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PRACTICAL TREATISE

ON

MEDICAL ELECTRICITY,

CONTAINING

A HISTORICAL SKETCH OF FRICTIONAL
AND VOLTAIC ELECTRICITY, AS
APPLIED TO MEDICINE:

WITH

PLAIN INSTRUCTIONS FOR THE USE OF

Electric, Galvanic, & Electro-Magnetic Instruments :

AND EMBRACING AN ACCOUNT OF THE MOST RECENT
RESEARCHES OF MATTEUCCI.

BY

GEORGE THOMAS FISHER, JUN.

AUTHOR OF "PHOTOGENIC MANIPULATION."

ILLUSTRATED BY WOOD-CUTS.

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TO

JONATHAN PEREIRA, Esq. M.D. F.R.S. & L.S.

PHYSICIAN TO THE LONDON HOSPITAL,
EXAMINER IN MATERIA MEDICA AND PHARMACY TO THE
UNIVERSITY OF LONDON,

THIS LITTLE WORK IS

(BY PERMISSION)

RESPECTFULLY DEDICATED,

BY HIS MOST OBEDIENT AND VERY OBLIGED

SERVANT,

THE AUTHOR.

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INTRODUCTORY REMARKS.

IN the following pages, the author of this little treatise proposes to lay before the reader the present state of our knowledge respecting Electricity as a remedial agent. From various causes, Electricity, as a medical agent, has not yet had a full and fair trial, such as to enable the practitioner at once to predict whether in any proposed case it will be a sanative or inert application. In the early history of Electrical Science, it was anticipated, that, from its powerful influence on the human frame, it would prove a valuable auxiliary in the healing art; nor were there wanting those who were sanguine enough to regard it as an universal medicine, which might be resorted to in every form of disease. Philosophers had before them an agent of subtlety almost unexampled, which traversed the animal frame with unmeasured and irresistible activity—which affected the nervous and muscular system in a manner which it was beyond the power of volition to controul; and it was neither absurd nor unreasonable to suppose that such an agent might, under some modification, produce a salutary effect upon the diseases to which mortality is heir. But unfortunately, the progress of the science was arrested by the extravagant assertions promulgated relative to its success. Charlatans of every degree found the electrical machine a lucrative article of trade; and there were not wanting well-meaning enthusiasts, who contributed to prolong the reign of Medical Electricity. The more sober part of the medical profession on the other hand, finding the utter fallacy of many of these assertions—ascertaining that many of the experiments which had been published were

utterly without foundation—and disgusted with the vauntings of empirical professors and itinerant charlatans—fell into the opposite extreme, and set their faces utterly against the application of Electricity as a medical agent.

From such causes as these, the scientific application of Electricity to medicine has made less progress than the success which has really, in many cases, attended its use, might have been justly expected to produce. It appears, from every trial of its power hitherto made, that, under judicious management, its application has never been known to produce consequences decidedly injurious, while in many of the most distressing disorders, it has frequently been of considerable service. These are powerful recommendations; and when it is added that it is an external and by no means painful remedy, and that it may be applied immediately to the affected part, without interfering with any other organ, its advantages must appear to be considerable. At the same time it must be remembered, that it is a remedy of such a nature, that a long continuance of its application is in most cases necessary; and it therefore becomes desirable that ample instructions should be given to enable any one to apply it, under its different modifications, with security and ease. The avocations of the medical practitioner, and the constant attention to his professional duties required of him, preclude the possibility of his searching amidst the pages of the various scientific journals for a knowledge of its successes, failures, or mode of application; and it is to obviate such a necessity, and to induce the profession generally to make trial of its efficacy, that the author has endeavoured to collect, in the following pages, those cases of disease which, upon creditable authority, have been relieved by the application of Electricity in some one of its forms. A portion of the treatise has been devoted to a detailed description of those instruments which are requisite for its administration, and their management.

A TREATISE ON MEDICAL ELECTRICITY.

CHAPTER I.

HISTORY OF MEDICAL ELECTRICITY.

They who first proposed the medical application of Electricity, seemed to have entertained mistaken notions of the mode of its action, and, consequently, to have erred in their calculation of the effects which it was expected to produce. They conceived that it was to operate as instantaneously upon disease, as it did upon the sensations or muscular powers of the animal frame, forgetting that there are very few cases in which a system of depraved vital action can instantaneously be changed into a healthy discharge of the functions of life.

The first application of Electricity as an agent for the relief of disease, must have been subsequent to the discovery of the Leyden vial in the year 1745. The shock occasioned by this instrument appeared at that period so tremendous, that the most absurd accounts were related of it. Muschenbroek, in writing to Reaumur on the subject, asserted that he would not receive another such shock for the whole kingdom of France. The impression was such, that respiration was affected, and two days afterwards he had scarcely recovered from the emotion and inconveniencce. M. Allamand, on taking a shock, declared "that he lost the use of his breath for some minutes, and then felt so intense a pain along his right arm, that he feared per-

manent injury from it." Winkler stated that the first time he underwent the experiment, " he suffered great convulsions through his body; that it put his blood into agitation; that he feared an ardent fever, and was obliged to have recourse to cooling medicines."

Nollet was the first who directly applied Electricity for the relief of disease. He had observed that its continued action on liquids accelerated their evaporation; and that this evaporation was far more considerable when the vessels which contained them had a larger opening, and were formed of good electrical conductors. Boze at the same time observed that electrified water issued from capillary tubes in the form of rays, in lieu of by drops. These two experiments were regarded as fundamental ones by those physicians who directed their attention to the application of Electricity as a medical agent:

In the year 1747, Johannes Pivati published at Venice the first of a series of errors and deceptions (whether intentional or not) which required much labour, and numerous elaborate experiments, entirely to disprove. He enclosed a quantity of Balsam of Peru in a glass cylinder, so that before its excitation no smell could be emitted. With this cylinder he electrified a man having a pain in his side. The patient returned home, fell asleep, and perspired; so effectually, we are told, had the virtue of the Balsam been thus conveyed to the patient, that his clothes and his hair were impregnated with the balsamic effluvium. In another experiment, a similar effect was produced upon a person in health, who was not made acquainted with Pivati's intention, and in whom the odoriferous emanation became perceptible to himself and others half an hour afterwards. Pivati next began to apply these powers to medical purposes: he professed to have cured, or rather disussed, an abscess in the foot of a young gentleman by electrifying him with a glass cylinder filled with certain drugs. His next patient was Signor Donadoni, Bishop of Sebenico, seventy-five years old, and greatly afflicted with the gout. The joints of his fingers had become fixed, and he had lost the power of bending his knees. Pivati tells us, that he proceeded to the cure by filling a glass

tube with discutient medicines, and so managing that the electric virtue might enter into the patient. The Bishop presently felt some unusual sensations in his fingers, and "in two minutes his lordship opened and shut his hands, gave a hearty squeeze to one of his attendants, got up, walked, smote his hands together, helped himself to a chair, and sat down wondering at his own strength, and hardly knowing whether it was not a dream. At length he walked out of the chamber, down stairs, without any assistance, and with all the alacrity of a young man." This and another similar cure, said to have been performed upon an old lady of sixty-one, may well account for the sensation that these experiments seem to have occasioned. The English and French physicians of that day attempted to verify these experiments of Pivati, which Winkler, a celebrated electrician of the period, professed to have repeated and found correct. In this attempt, however, they completely failed; and, after receiving from Winkler some tubes properly prepared, these also were submitted to a fair trial, and the conclusion at which they arrived was, that Electricity had no effect in forcing odoriferous effluvia through the substance of glass vessels. The zeal of the Abbé Nollet even carried him into Italy, that he might witness these wonderful performances for himself; but he also came back convinced that the odours were not transmitted through the glass, and that the enclosed drugs had no medicinal effect, although in certain cases of paralysis, &c. the Electricity itself was clearly beneficial. Dr. Bianchini also, of Venice, published an elaborate refutation of these fallacious experiments. To the clearly ascertained fallacy of these experiments of Pivati, and the absurd boasts of electrical empirics, of which mention has already been made, must be attributed the general apathy of more sober-minded practitioners, with regard to the use of Medical Electricity, which, like many other sciences, has suffered more from the extravagant eulogium of friends, than from all the attacks of its avowed enemies.

The discovery of Galvani in the year 1791, and the subsequent invention of the Voltaic Pile again aroused the attention of physiologists to the apparent identity of electricity and nervous

action, and the possibility of applying this agent to the relief of disease. The physiological effects of Galvanism, which almost exclusively occupied the attention of philosophers previous to the discovery of the pile, were those in which contractions in the muscular parts of animals were exhibited. The source of that surprising power which called forth such sudden and forcible muscular contractions, as took place when the nerve and muscles of the limb of a frog were respectively in contact with different metals which were themselves made to communicate, either directly or by the intervention of other metals, was most anxiously sought after; and it was not till after a long period of laborious research, in which a prodigious number of experimentalists in every part of Europe engaged, and occasionally involved themselves in inextricable mazes of perplexity, that the identity of the Galvanic and the Electric agencies was recognized and finally established. The ardour and perseverance with which these experiments were carried on, may be gathered from the fact that many of the philosophers subjected themselves to no inconsiderable suffering for the purpose of thoroughly carrying out the enquiry. Humboldt, for example, informs us that, with a view of more precisely ascertaining the nature of the contractions produced by different metals, he purposely applied two blisters over the deltoid muscles in his own arms; he covered one of the wounds with a large silver medal, and the other with a plate of zinc, and by means of a zinc wire established a communication between the two metals: the result of the contact was not only a violent smarting sensation on the blistered surfaces, but an alternate contraction of the muscles of the shoulder and the neck. When the blistered surfaces had been exposed to the air for the space of half an hour, so as to have become covered with effused lymph, the effect of the Galvanic contact was much diminished; but when, under these circumstances, a few drops of an alkaline solution were poured on the coating of lymph, the sensibility was immediately restored, the pain became extremely violent, and the contractions were renewed and succeeded each other several times successively. Not

satisfied with these results, he wished to obtain proofs of the farther action of Galvanism on the actions of the blood-vessels. Having abraded the skin of the wrist, attended with the effusion of a small quantity of blood, at the part where the radial artery is extremely superficial, he laid on the wound a coating of zinc, touching it also with a silver coin. As long as the contact continued, he felt a tension which extended to the ends of his fingers, together with a shooting and tremulous sensation in the whole extent of the palm of the hand; this painful sensation became manifestly more intense, whenever the edge of the coin was brought in contact with the zinc, and the irritation likewise augmented the discharge of blood. The coagulation of the blood, however, intercepted the action and diminished the effect; Humboldt now took a scalpel, and having made a slight incision in the part, the Galvanic process, which he continued for several days successively, produced a very decided inflammation.

During this period, when so much attention was directed to physiological researches, attempts were likewise made to apply Galvanism to medicine. Creve proposed its application to distinguish real from apparent death or asphyxia: when the muscular fibres contract, it is a proof that irritation is not entirely destroyed, and under such circumstances, it would be utterly impossible to decide that the individual was really dead; but Humboldt, who experimented on the same subject, was inclined to believe that Galvanism, in these instances, might induce error, since the practitioner might decide that death had really taken place, in a case where, probably, there was but a more or less temporary want of irritability.

Many experiments were made at this time at the Ecole de Medicine, relative to the treatment of disease by Galvanism; the commission who drew up the account of these experiments came to the conclusion that, "the effects of Galvanism were more apparent and more powerful in the nerves and muscular system than ordinary electrical machines; that it gives rise to violent contractions, painful sensations of pricking and burning in those parts which a state of disease renders insensible to

strong shocks or mere sparks, and that the duration of this effect is such, that it would seem to authorize the hope of discovering in this remedy an efficacious excitant, likely to prove of no slight advantage in the treatment of diseases."

Grapen Gresser, a colleague of the celebrated Humboldt, published a work on the employment of Galvanism in the treatment of certain maladies; he asserted that Galvanism could not only prove of service for the distinguishing of nerves from other organs, and particularly from vessels, but even for the indication of the distribution of superficial nerves. The effects, according to this writer, vary with the nature of the poles in contact with the affected parts; if, for example, a plate of zinc and another of silver be taken and placed in contact with a blistered surface, the sore covered by the zinc will first cease to discharge, and will soon cicatrize. His experience led him to assert that Galvanism was frequently useful in paralysis of the extremities, as also in compression of the brain; in weakness of sight and gutta serena only due to the want of excitability in the optic nerve; in deafness, caused by nervous weakness; in hoarseness and aphonia; in paralysis of the sphincter ani and the muscles of the bladder. About the same time, Lebouvier Desmortiers proposed the use of Galvanism for the treatment of urinary calculi; a round very hard stone, weighing a grain, was completely dissolved in twenty-four hours.

In certain experiments made upon frogs, Nobili believed that he had discovered a remedy against tetanus and paralysis. He observed that the contractions in the limbs of a frog increased under the action of one kind of electrical current to such an extent, as to produce an artificial tetanus, while a contrary current completely did away with this effect: and in his *Traite de l'Electricité*, Beequerel remarks, relative to Nobili's experiment, "that these observations are in the highest degree important, and deserve more extended enquiry; for, if we can succeed in destroying at will tetanus, which has been brought on in the frog by art, we may entertain the hope of curing tetanus in man, a disease which inevitably proves fatal to the individual who suffers from it."

Marianini has published a means for the useful application of Electricity in the cure of some cases of paralysis and paraplegia. He recommends that through the affected member should be passed for many days and even for many weeks, not a continued current, but rapidly successive Voltaic discharges, at first feeble, but gradually increasing in power; and he assures his readers that he has succeeded in effecting many cures by this means.

Another individual, who has devoted much time to the study of Medical Galvanism, has taken advantage of the calorific effects of the Voltaic battery for the production of internal moxas. It is known, doubtless, to most of our readers, that the resistance offered to the Electrical current by some metals, is such as to produce the ignition of the metals; thus, for example, if a thin piece of platina wire be placed between the poles of a battery, it will become red or even white hot. The plan of the writer to whom allusion is made, Doctor Fabré Palaprat, is to introduce into the part which he wishes to cauterize a thin platinum wire, connected with one of the poles of a powerfully charged battery, while the other pole communicates with the surface of the body: the electric current, when sufficiently intense, renders the platinum wire red hot, and thus destroys the organic tissues in contact with it; at the end of a few days a slough forms, which is easily removed. It is needless to observe that such an operation must be performed with extreme circumspection.

In Italy, the medical application of Voltaic Electricity has been studied in another point of view, and as there appears much promise, in this theory, of arriving at certain general and definite results in the therapeutical employment of Electricity, we shall make no apology for speaking of it somewhat in detail.

Monsieur Orioli, one of the most distinguished philosophers of whom Italy can boast, has published some theoretical considerations concerning a new means of modifying the laws of vitality, by changing the electrical state of living parts. These considerations are based on theory alone, but as they are

not rejected by philosophers, it is for this reason that a resumé of his propositions is here subjoined. After having recalled to the recollection of his readers the fact that in inorganic chemistry, the influence of the electrical states of bodies produces changes in their chemical properties, he asserts that this effect ought equally to take place in organic chemistry, and that if living substances do not exhibit the same kind of affinity with dead bodies, this difference ought to be considered as dependent on the existence, in the former, of some peculiar electrical state, differing from that which exists independently of life. "In the present day," he adds, "the great majority of physiologists believe that, life must be considered as the result of an action of certain piles, artistically arranged, and continually acting in such a manner that every organ is an electrical apparatus, and that all these piles have a common and reciprocal relation, so that the instant life ceases, the electrical actions have no longer the power of reproduction.

In acknowledging the truth of these principles, such piles, set in action by some unknown cause, dependent on vitality, ought necessarily to produce a positive or negative polarity in organs where, apart from the Voltaic action, it would not exist; from this it must result that at these poles there must be secretions, excretions, and special modifications, which cease the instant that the electrical action is destroyed.

In the same manner that we have succeeded in destroying the action of the sea upon copper by rendering this metal electro-negative, ought we to be able to change the nature of secretions in animals, by reversing the polarity of the organs which furnish them. The stomach, for example, secretes acids; the positive state predominates. If this secretion is too abundant, we must increase the contrary electrical state; it will be the same with the kidneys, when the urine abounds in uric acid, and gives rise to stone. We should impart to them an electro-negative state. In the same way, chancre engenders a secretion which, according to Crawford, turns syrup of violets green; chancre then proves that the negative polarity prevails, and we must accordingly give it a contrary state."

M. Orioli recommends, that before attempting to apply Electricity therapeutically, we should study the nature of the secretions produced, in order that we may be enabled to create in the secreting organ a proper electrical state for bringing about contrary effects. These secretions will be acid, alkaline or neutral. If they be acid or alkaline no difficulty will exist; if they are neutral we should apply to the affected part the pole of the battery opposed to that electrical state which belongs to the normal condition of this part.

He proposes for this purpose, to apply, in two convenient parts of the body previously denuded, after the method of Mansford, two discs, the one of zinc, the other of silver, connected to each other with a metallic wire, keeping them in their proper situations by convenient bandages, for days, weeks, and even months, and only cleaning them when absolutely necessary. According to this distinguished philosopher, this remedial agent may be employed in the interior of the bladder, by introducing a sound whose extremity only is a conductor, while the remainder is covered with an insulating coating. This sound might be connected with one pole of the voltaic apparatus, while the other should be made to communicate with the kidneys. "Perhaps," he adds, "by this means we may succeed in decomposing calculi much more easily than has hitherto been imagined."

If the observation of another experimentalist, which we have already quoted (page 14) be true, that the sore, corresponding to the negative pole, has always a tendency to cicatrize, it might be possible to apply this fact usefully to the cure of certain inveterate ulcers, by bringing them into contact occasionally with the negative pole of a battery."

In our own country, our knowledge of the effects of Electricity remedially, is chiefly due to Mr. Carpue, Dr. Wilson Phillips, Dr. Golding Bird, and others; but as we shall have occasion hereafter to speak of the results arrived at from their experimental researches, we do not deem it necessary in this place to say more in detail of them.

CHAPTER II.

PHYSIOLOGICAL EFFECTS OF ELECTRICITY AND GALVANISM—ANALOGY WITH NERVOUS INFLUENCE.

WE come in the next place to consider the physiological effects of Electricity under its different forms;—and first of that modification we call FRICTIONAL or STATIC Electricity.

It has long been suspected, and indeed rendered almost certain by a variety of facts, that the electrical state of the atmosphere has an appreciable influence on the animal economy. The lower animals seem aware of an approaching thunder-storm, as would appear from the uneasiness which they manifest, the cries which they utter, and their running about in a state of alarm, in search of shelter.

“ Prone to the lowest vale, the aerial tribes
Descend: the tempest loving raven scarce
Dares wing the dubious dusk. In rueful gaze
The cattle stand, and on the scowling heavens
Cast a deploring eye:”—

Many individuals also of the human species, particularly those labouring under certain chronic complaints, or who possess what may be called a great degree of mobility of the nervous system, experience at such times very peculiar sensations. Observations such as these, and many others of a similar description which might be quoted, demonstrate very completely that the animal machine is frequently sensibly affected by the electricity of the atmosphere; and there is even nothing improbable in the conjecture, which has often been hazarded, that the salubrity or insalubrity of particular districts and seasons, the existence and character of epidemic diseases, are in some way connected with, if not immediately dependent on, the same influence.

The effects of artificially produced Electricity on animals vary according to the mode of applying it. If the individual be insulated, and placed in connexion with the prime conductor of a

machine, the whole surface of the body becomes electro-positive, and the electricity is constantly and silently discharged from all pointed parts of the surface, as from the hairs, fingers, etc. This mode of administering electricity does not appear to be uniform on different individuals. In some, the pulse is at first quickened, in others, it is unchanged; while in some it is, after ten or fifteen minutes, reduced in frequency. Copious perspiration sometimes breaks out; but it is not unlikely that these different effects are in part referable to the influence of mental emotion.

The electrical spark occasions a sharp pungent painful sensation—redness, and sometimes a small circumscribed spot or wheal, which, however, generally quickly disappears. The spark received from substances resinously electrified differs, in some respects, from that which issues from surfaces vitreously charged. It is more pungent, and has a different shape, being shorter, and not so regular in form. As medicinal agents, however, they appear both to produce similar effects. A contrary opinion has indeed been maintained by some, who have represented resinous electricity as a sedative and vitreous as a stimulant. This theory, which is quite unsupported by facts, is not a modern invention. It originated in 1779, with Bertholon, of Montpellicier, who resolved diseases into two classes—those which depended on an excess, and those which were the consequence of a deficiency of the electric fluid, and treated the former with resinous, the latter with vitreous electricity. It is not necessary to enter upon any formal refutation of an hypothesis so absurd.

The most violent form of electrical effect is the *shock*. If a charged Leyden jar be discharged through the body, which may readily be done by applying one hand to the external coating and the other to the knob, a sensation of an exceedingly distressing kind is experienced, which is usually and very appropriately denominated the *shock*. The distance to which the shock extends depends upon the magnitude of the coated surface, and upon the intensity of its electricity. Thus, with a certain charge, it is felt at the wrists; with a stronger at the elbows; and with a still stronger even across the chest. A dull kind of pain is usually felt at the joints, which is probably to be traced to the

resistance which the force experiences in passing from one bone to another. If the diaphragm form part of the circuit, it is immediately thrown into a temporary state of contraction. If a strong shock be passed through this muscle, the sudden contraction will act so violently on the air of the lungs as to occasion a loud and involuntary shout; while a small charge frequently occasions a violent fit of laughter; persons of great nervous sensibility being much more readily affected than others.

When a small charge is passed through the spine, it instantly deprives the individual of all muscular power, so that if he be standing at the time, he either sinks on his knees, or falls to the ground. Mr. Singer, a celebrated electrician, "once accidentally received a considerable charge from a battery through the head; the sensation was that of a violent but universal blow, followed by a transient loss of memory and indistinctness of vision, but no permanent injury ensued." In persons killed by lightning, red streaks are frequently observed on the skin. It is said that marks are often observed, indicating the passage of the electric fluid along the spine. The blood is usually fluid, and the muscles flaccid; though occasionally rigidity of muscles has been found. It has likewise been observed that the body undergoes, in such cases, rapid putrefaction.

From these facts it will be seen that electricity produces a paralyzing effect when brought to bear upon the centre of the nervous system. But when transmitted to the muscles of a limb, the invariable consequence is their spasmodic contraction; and this is true even though the member be in a paralytic state. From some recent researches, it is highly probable that the muscles are not directly sensible to the stimulus of electricity, but that they are thrown into convulsive action by the electric fluid, merely because of its traversing the nerves by which they are supplied.

PHYSIOLOGICAL EFFECTS OF GALVANISM.

The Galvanic current, when brought to act on the living body, is capable of producing three classes of effects, viz. :—

1. The production of peculiar sensations—
2. Of muscular contractions—

3. An influence over the organs of secretion. Upon these we will observe in succession.

And first, with reference to the production of certain sensations. Voltaic Electricity acts in a manner peculiar to itself on all the nerves of sensation. If a slip of zinc applied to the tip of the tongue, and a silver coin placed between the gum and upper lip be brought into contact, an acid taste is experienced, but if the position of the metals be reversed, the taste is then decidedly alkaline. In order to the production of these sensations, the tongue must be covered with some moisture, for, when perfectly dry, no such impressions are perceived. For this reason it has been suggested, and it is quite probable, that such sensation is owing not to any direct action of Galvanism upon the tongue, but to the decomposition of the salts of the saliva, and to the consequent developement of an acid and an alkali at the opposite poles. When this experiment is performed in the dark, a flash of light is perceived, which is observable not only on bringing the metals into contact, but also upon separating them from each other; and it is worthy of remark that the flash is most vivid when the zinc is in contact with the tongue. A more decided effect is produced by attaching to the eye-ball, beneath the eyelid, a slip of tin-foil, placing a silver spoon in the mouth, and connecting it and the foil. The experiment succeeds also in the light, and whether the eye be open or shut; and at the instant of contact of the metals, the pupil is observed to diminish in size, just as when the eye from comparative darkness is suddenly exposed to the glare of sunshine. By affecting the auditory nerve, in like manner, a peculiar sound is excited.

Upon the pain produced by Galvanism it is unnecessary to dwell at any length. It is an invariable accompaniment of the sudden transmission through, or withdrawal from, the body, of a strong electric current. During the completion of the circuit also, a disagreeable sensation is experienced, which becomes extremely distressing if the part of the body at which the current enters, or from which it issues, be deprived of its cuticle, or if there be a sore or cut in its line of passage. Pain may even, indeed, be produced by a very feeble current.

PRODUCTION OF MUSCULAR CONTRACTIONS.—When any part of an animal, either still living or recently killed, is made to form part of a voltaic current, a shock is experienced, closely resembling that caused by a weakly-charged Leyden jar, and the intervening muscles are thrown into convulsive action. This effect is equally produced whether the current be applied to the motor nerves themselves, or to the central organs of the nervous system. Thus, if while the negative pole is touched by the fingers of one hand, the other be brought into contact with the positive end of a battery, a concussion will be felt in both hands, which will extend to the wrists, the elbows, or even the chest, according to the intensity of the developed electricities. And it is further to be remarked, that not only is this shock felt when the circuit is completed, but also at the instant when it is broken, while during the maintenance of the circuit, no such effect is perceived. In order, however, to the production of these phenomena, it is necessary that the circuit be completed or interrupted with rapidity; for if the electric current be gradually admitted into, or withdrawn from, the body of an animal, no spasms will ensue. This fact is interesting, and in a practical point of view should be borne in mind, as will be seen when we come to treat of the remedial application of Galvanism and Electro-Magnetism.

From the experiments of various physiologists, it would seem that the effect of the voltaic current is more powerful on the voluntary than on the involuntary muscles. The muscles of the animal body may, it is well known, be divided into three classes:—the voluntary, the involuntary, and those of a mixed character. The muscles which move the limbs are voluntary; the heart is an involuntary muscle; and the diaphragm may be cited as an organ of the mixed class. Now, upon all three the galvanic current exercises a similar power, that is, it stimulates them to convulsive action. The involuntary muscles are doubtless much less affected by it than those which are influenced by the will; and it has even been contended by some that they are entirely exempt from its influence. This opinion, however, has been most satisfactorily refuted by the experiments of Fowler,

Nysten, Humboldt, and other eminent physiologists; and it is therefore needless here to dwell on the matter.

Another curious fact connected with this interesting subject is, that to produce the convulsions of a muscle by this agent it is not necessary that the electric current should extend to it, or that it should be included in the circuit. It is quite sufficient that the circuit should be completed through the smallest portion of the nervous trunk which supplies the muscle. This fact is amply proved by the experiments made by Nobili.

From all the facts then that have been collected on the subject of muscular contraction caused by the application of Voltaic Electricity, the following conclusions may be deduced:—

1. The muscular fibre is sensible to the stimulus of Galvanism when applied directly to it.

2. When an electric current is suddenly transmitted through a nerve to a muscle, or in the inverse direction, the muscle is thrown into spasmodic action.

3. The same effect is produced upon suddenly interrupting the electric current, when moving in either of the directions just described.

4. Precisely similar results are obtained upon completing the circuit through a portion of the nervous trunk which is distributed to a muscle, and upon interrupting it after being completed.

5. The most powerful contractions are produced by transmitting the direct current.

6. The next in point of energy are those which occur upon interrupting the inverse current.

INFLUENCE OVER THE SECRETORY ORGANS.—It was our celebrated countryman, Dr. Wollaston,* who published the earliest conjectures in reference to the influence of Galvanism upon the secreting organs. Reflecting upon the wonderful powers of decomposition and transfer which Davy had lately shewn that the pile was capable of exerting, and upon the fact of a distinct electric apparatus having been detected in certain fishes, it

* Philosophical Magazine, vol. xxxiii. p. 488.

occurred to this eminent philosopher that the products of secretion might be due to electricity of low intensity, and he even suggested the nature of the secretions, as to acidity or alkalinity, as a test of the species of electric fluid accumulated in each organ. Thus, the milk, the perspiration, the urine, as being all acid, should upon this principle be considered as proceeding from organs in an electro-positive state; while the bile and different serous secretions, as containing a free alkali, would argue an electro-negative state of the parts from which they are discharged. Matteucci has espoused this theory, and added the important observation, that the animal principles occurring in the several secreted fluids, abound in elements of corresponding electrical relations; or that in the acid, oxygen and azote, in the alkaline, carbon and hydrogen, are chiefly to be found. It will be seen, on reference to our first chapter, that the same theory has been promulgated in Italy by M. Orioli; and upon it, he has endeavoured to establish a method of correctly applying electricity for a restoration of these organs to a healthy action, when in a state of disease.

Dr. Wilson Philip, however, is unquestionably the individual who has espoused this theory with most zeal, and illustrated it with most success. Arguing, that as the Voltaic current excites the functions of the sensitive and motor nerves, it also may exercise a similar influence over those nerves which are distributed to the organs of secretion, Dr. Philip endeavoured to establish the truth of this opinion in the case of the gastric juice. He divided the *nervi vagi* in a rabbit, and found that the digestive process was stopped. The respiration was thus immediately rendered laborious, nausea and fruitless attempts to vomit supervened, and the animals finally died, apparently of suffocation. Upon opening their stomachs, the parsley with which they had been fed was found quite unaltered. The same experiment was then performed upon other rabbits, with this difference, that galvanic currents were sent to the stomach, by applying one of the poles of a small pile to a slip of tin foil rolled round the lower ends of the divided nerves, and the other to a disc of silver laid upon the epigastrium. In all these cases dyspnoea and

tendency to vomit were wanting; and the animals being killed after the currents had been continued for twenty-six hours, the parsley was found perfectly digested, and the stomach of each exhaled the odour peculiar to this organ during digestion. From experiments such as these, very frequently repeated, and always with the same results, Dr. Philip concludes that the secretion of the gastric juice is under the control of the nervous influence, and that this latter is identical with, because it may be replaced by, the power developed by galvanic combinations. Dr. Philip, however, does not confine himself to this inference, which, if not rigorously established, would at least appear supported by plausible arguments; but goes to the extent of asserting, that "Galvanism is capable of performing all the functions of the nervous influence in the animal economy;" or, to use his own words, besides "combining the elementary parts of the blood in the formation of the secreted fluids, it conveys impressions to and from the sensorium, excites the muscular system, and produces an evolution of caloric from arterial blood."

But it is necessary to state, that the conclusions of Dr. Philip in reference to the gastric juice, and the alleged facts upon which he professes to found them, have not met with universal adoption. Messrs. Breschet, Milne Edwards, and Vavasseur have, from experiment, been led to believe that Galvanism acts merely as a stimulant upon the glands which secrete the gastric juice, and that similar effects may be produced by anything causing a mechanical irritation of the lower ends of the divided nerves. They moreover conceived that they had established the following propositions, viz:—That the simple section of the pneumo-gastric nerves retards, but does not entirely prevent the digestive process: That the excision of a portion of them almost completely suspends this function: That in both the preceding cases, digestion is restored by the transmission of electric currents along the nerves of the stomach.

In justice however to Dr. Philip, it should be mentioned that Mr. Cutler,* operating under the direction and with the assist-

* Med. Chir. Review, vol. iii. p. 589.

ance of Dr. Philip himself and Sir Benjamin Brodie, was not enabled, by any means of mechanical irritation, to produce those effects which are upon all hands admitted to follow upon the due application of the electric current.

From this subject, we now pass to the consideration of the

ANALOGY OF ELECTRICITY WITH NERVOUS INFLUENCE.

From what we have previously said, it will be evident that a remarkable analogy exists between the Galvanic energy, and the nervous influence; the former of which may be made, as in the experiments of Dr. Philip, to supply the place of the latter. The investigations which have been made into the anatomical structure and the nature of the phenomena evinced by the gymnotus, torpedo, silurus, &c. clearly prove that the effects they produce, are not the result of a peculiar force evidenced by these fish, but is the common one of nervism, and the force which traverses all nerves may be electricity. This is a notion which has long been entertained by many of our ablest physiologists; for experiment shews us, that a current of electricity, sent along the different nerves, produces effects precisely analogous to those which are consequent upon the transit of the nervous force: if it be sent along motor nerves, muscular action is the result; along sensitive ones, we affect the sensation peculiar to that nerve. But it may be argued, that if we assume that the nervous force is electrical, because a current of electricity sent along the nerves will give rise to effects simulating the vital functions, we ought, upon the principle of action and reaction, to be able, during the natural performance of these functions, to detect a current of electricity. Many experiments have been made, for the purpose of ascertaining whether this is the case, and generally these experiments have been successful in their results; and not only in the lower animals, but in man have these researches been carried on. Later observers assert that the current of electricity is increased after spirituous drinks, but diminished as the body cools; in other words, it is in the ratio of the chemical changes of the respiration. Matteucci has observed a deviation of the galvano-

meter (an instrument adapted for the detection of slight currents of electricity) amounting to fifteen or twenty degrees, when the liver and stomach of a rabbit were connected with the ends of a galvanometer; an action, which was not due to the different chemical properties of the secretions, for it ceased with death; and more recently, Professor Zantideschi and Dr. Favio assert that, in all warm-blooded animals there are two Electro-Vital or Neuro-Electric currents; one external or cutaneous, which directs itself from the extremities to the cerebro-spinal axis, and the other, internal, going from the cerebro-spinal axis to the internal organs. These currents grow weaker in proportion as life ceases, or as pain is felt; while the convulsive or voluntary movements give a strong current, or increase the discharge.

Many other experiments which tend to confirm the identity of nervous force and electricity may be cited. Dr. Prevost, of Geneva, has succeeded in magnetizing very delicate soft iron needles by placing them near the nerves, and it is a well known fact that this property is communicated to soft iron or steel, by a current of electricity transmitted at right angles to it. Vauseur and Berandi have likewise succeeded in rendering needles magnetic, by passing them through the nerve of a living animal, while division of the cord, they say, destroys this property, but the inhalation of oxygen increases it. M. David also reports that he has seen a galvanometer deflected when its poles were inserted into the bared nerve of an animal, and it was made to move, and that there was no motion when the spinal cord was divided.

But supposing that we had never yet detected a current of electricity traversing the nerves during functional activity, we are not therefore to conclude that there is no traverse of an electric current. We should bear in mind the great effects which our weakest, and otherwise almost inappreciable currents, are capable of producing on the living muscle; and to detect a current of as weak tension as must be that of the nerves, we ought to possess galvanometers as delicate as living muscle. Matteucci, indeed, has lately made use of this, and the result is perfectly

satisfactory. By connecting a prepared leg of one frog with the nerve and external muscle of another, violent contractions ensued, and by connecting the interior of a series of frogs' legs with the exterior of the next, and so on, a battery was formed whose effects were very considerable. From all these facts there can scarcely remain much doubt on the matter. Dr. Watson, in his Lectures on Medicine, observes, "I incline to the opinion that the influence which originates in the grey matter, and is transmitted by the white, will be found at last to consist in, or be nearly allied to, electricity." And that most profound philosopher, Faraday, remarks, "that from the time it was shown that electricity could perform the functions of the nervous influence, he has no doubt of their very close relation; and they probably are the effects of one common cause." Sir John Herschel too says, that the present state of electrical science warrants the belief, that the brain and spinal marrow form an electrical organ which is spontaneously discharged along the nerves at brief intervals, when the tension of the electricity reaches a certain point.

Such are the arguments which have been adduced in favour of the identity of the Nervous and Electrical forces. But recently Matteucci has totally denied their analogy, and from his extensive researches on the subject, much weight should be attached to his opinion. It would be impossible within the limits of so small a work to present to the reader anything like a complete account of the experiments upon which his opinion is founded. We shall, therefore, content ourselves with briefly stating his views, referring the reader, who may be anxious to pursue the enquiry to the elaborate work of the philosopher to whom we allude.* Matteucci is of opinion, that although at a first view apparently identical, and that possibly the one is capable of giving rise to the other, the nervous and electrical forces differ as much from each other as any other forces of matter—light and heat for example; and that the analogy between the two former is but of the same nature as between heat, light, and electricity; nay,

* *Traite des Phenomenes Electro-Physiques des Animaux*—par C. Matteucci, Paris.

further, that as electricity is capable of exciting a nerve, and thus producing contraction and sensation ; so heat, a chemical or mechanical action, can be made to produce the same effects, and that it would therefore be equally right to insist upon the identity of heat or chemical action with the nervous force. That there is an electric current produced in the muscles themselves, by the chemical changes which take place, the result of the functions of nutrition ; that the nerves themselves are but conductors of the current developed in the muscles to which they are nearest ; that throughout the whole of the nervous system there is an ethereal medium, which may have some particular arrangement in this system—as is admitted with respect to certain crystals. When the organic molecules of the nerve are deranged by some cause, the ether, or more correctly speaking, the nervous fluid, is thrown into a certain state of vibration, which acting on the brain, produces sensation—on the muscles, motion. This derangement or vibration may be produced by an electric current, by other stimulants, heat, chemical or mechanical action, in the same way that it is naturally produced by the will. That the electric current generated in the muscles, and always directed from the interior to the exterior of the muscles, in its influence on the nerves, only acts by putting into a state of vibration the particles of ether or the nervous fluid. Such are the two theories on this important question, which we leave without further remark to the reader, since it would be out of place in a work, whose object is more particularly to describe the curative effects of electricity, to enter into more extended detail.

CHAPTER III.

OF THE DISEASES IN WHICH MEDICAL ELECTRICITY MAY BE APPLIED WITH HOPES OF SUCCESS.

“THE uses of Electricity,” observes Dr. Pereira,* “are partly rational, partly empirical. When the indications are to excite a nerve of sensation or of motion, or to produce a temporary contraction of the muscles, or to promote transpiration and secretion, its employment may be regarded as rational. But it is used sometimes beneficially, in several diseases in which these indications are by no means obvious. In such its *methodus operandi* is unknown, and its use may be regarded as empirical.”

We will proceed then to speak seriatim of the diseases in which the application of Electricity has been attended with success. The therapeutic uses of Electricity in any of its forms may be classified in the following manner:—

1. TO STIMULATE THE NERVES OF SENSATION.

In cases of *Nervous Deafness*, the application of electricity frequently affords relief; and from the experience of Mr. Carpué,† about one out of five patients are permanently cured. If frictional electricity be employed, sparks are to be thrown on, (by means of the director described in the succeeding chapter, page 39) or drawn from the mastoid process, the parts around the meatus auditorius externus, or the bottom of the meatus. If preference be given to voltaic electricity or electro-magnetism, one pole of the battery or director of the coil is introduced into one ear, and the other into the opposite ear; the circuit is then to be rapidly broken and completed a number of times.

Amaurosis. (Dimness of Sight.)—In this disease, the aura and sometimes slight sparks and shocks have been tried. It would appear that the prospects of success depend principally, if not entirely, upon the time the disease has existed. Mr. Hey pub-

* Elements of Materia Medica, vol. i.

† Carpué's Medical Electricity. Lond. 1803.

lished several successful cases of the use of Electricity in Amaurosis.* He never saw the least benefit when the disease had existed for two years. Voltaic Electricity has also been employed in this disease, when other remedies have failed; and, indeed, it will be obvious that this modification of electricity may be more readily transmitted through the ball of the eye, so as to traverse the retina, or be confined to those twigs of the first branch of the fifth pair of nerves which ramify on the forehead above the orbit, and upon the state of which alone, Majendie has shown that *gutta serena* often depends. It must, however, be employed with great caution, as its mechanical effect is calculated in many cases, to aggravate the malady.

Aphonia. (Loss of Voice.)—In some few cases, the application of Voltaic Electricity in this affection has been attended with success. The circuit may be completed through the organs chiefly concerned in the production of the voice, by placing a shilling upon the tongue, and touching it with the negative wire of a battery, whose other pole is alternately brought in connection with and separated from different parts of the external larynx—a method successfully employed by Mr. Miles Partington, in a case detailed in the London Medical and Physical Journal.

2. TO STIMULATE THE MOTOR NERVES.

The first disease of this class of affections which we shall notice is *Paralysis*; and there can be no doubt that electricity has been of considerable service in many cases of this kind. But it is necessary, before attempting the application of electricity, for the practitioner to assure himself of the real nature of the disease. If it depend on some lesion of the cerebro-spinal centre, relief by electricity is not to be expected. It is only calculated to be of service when the malady arises from some functional disorder of the nerves. In cases where the use of the parts was originally paralysed by effusion in some portion of the cerebro-spinal centre, and there is reason to believe that the blood effused has been absorbed, and that the paralysis remains from desuetude only,

* Medical Observ. and Inq. vol. v. p. 1.

stimulating the motor nerves by electricity is likely to be serviceable. There are several curious cases on record, with regard to the effect of electricity in Palsy. In the *Haerlem Transactions*, a case is recorded in which a hemiplegic patient recovered the use of his side after a hundred strokes from the *gymnotus electricus*, or electric eel; and in the *Medico-Chirurgical Review*, the following curious but well-authenticated anecdote occurs. A vessel on the Atlantic was struck several times by lightning, inasmuch that many of the crew were strongly electrified. Among the passengers was a man who had been paralysed in both his inferior limbs for three years; at the time of the electric discharge he lay on his bed, but soon after perceived the return of power to his limbs, and was enabled to rise with the perfect use of them. The cure in this case was permanent.

But though it is generally admitted that electricity is occasionally a successful remedy in Palsy, still the remarks we have made above must ever be borne in mind; for in those palsies which depend upon compression of the brain, the application of so powerful a stimulant is likely to increase the evil we seek to remedy, especially when it is so employed as to act upon the vessels of the head. Applied as a topical remedy it will be less apt to produce mischief; and for this purpose the operation of electro-puncture, presently to be described, may sometimes be resorted to with advantage. The facility afforded of gradually increasing the force of the shock by the employment of the galvanic apparatus, renders galvanism a more safe and suitable arrangement than electricity; and according to the conclusions of Dr. Bardsley, its efficiency is superior to that of electricity.

The researches of Matteucci, to which, allusion has been already made, have thrown much light on the use of voltaic electricity in paralysis, and from the work before cited, we quote his remarks on its therapeutical application:—

“These are then facts, which independently of theory, or of all hypothesis on the nature of nervous force, may guide us in the therapeutical application of the electric current in paralysis. In fact, we may admit that in some forms of paralysis, the nerves of the affected limb are altered in some way similar to that which

would be produced by a continued passage of the electric current. We have seen that to reimpart it to a nerve, which has, by the passage of an electric current, lost its excitability; it is necessary to act upon it by a current made to traverse it in an opposite direction. In the same way, to cure the paralysis, we should pass a current of electricity through it, in an opposite direction to that which would have produced it. From this it will be seen that we are supposing that the paralysis we are about to submit to electrical treatment is either of the nerves of motion or of sensation. Thus, for a paralysis of a nerve of motion, the inverse current should be applied; while for a nerve of sensation, the direct current should be had recourse to. In cases of complete paralysis there is no reason for selecting one in preference to another. There is still another rule for its application, which theory has taught us—it is, never to continue the application of the current for too long a period, lest we should augment the malady which we wish to cure. The time for the application of the current should be shorter in proportion, as the current itself is more intense. Theory has taught us the necessity of applying the electrical current, varying the intensity according to the extent of the disease, for two or three minutes, at intervals of a few seconds. After these two or three minutes, during which time twenty to thirty shocks should be given, the patient should be left at rest some little time, after which the treatment may be renewed."

The cases of cure, which are recorded by Matteucci, prove incontestably the necessity for perseverance ere we can hope for successful results. Marianini in some cases continued the application of the voltaic current for some months; in two cases the cure was not effected till two thousand five hundred shocks had been passed through the paralysed limb; and Matteucci adds a case, in which both inferior extremities were paralysed; but where, after a continued electrical treatment, their use was perfectly restored. "These results," he adds, "although far from numerous, are sufficient to induce physicians seriously to study electro-physiological phenomena, in order that we may be able scientifically to adopt some therapeutical method of combating

a disease which unfortunately too often resists all the efforts of the physicians."

Tetanus.—In our introductory chapter, we have already made mention of some experiments of Nobili, from which that philosopher was induced to believe that voltaic electricity might prove a remedy in tetanus. Matteucci has confirmed this opinion; to describe the experiments on which his opinion is founded, we must again have recourse to his own words. "All narcotic poisons, such as opium and nux vomica, administered to frogs, first stupify, then excite them, and some little time before death they are seized with very violent tetanic convulsions. If in animals in this last stage we pass a current of electricity of a certain intensity, we observe the stiffness of the limbs disappear, and the convulsions cease. These frogs died after a certain time, but without exhibiting any symptoms of tetanus. In order to render the contraction which takes place at the commencement of the application of the current less powerful, it is better to employ the inverse current." A case of tetanus is related, in which an opportunity was afforded of trying the effects of this agent. The patient, during the time he was submitted to the electric treatment did not suffer from such violent convulsions—he could open and shut his mouth, circulation and secretion appeared to be re-established. Unfortunately these symptoms of amelioration were but temporary. "I dare not hope," adds the author, "that the application of the electrical current will invariably bring about the cure of tetanus; but I believe the opinion to be well founded, that during the passage of the electric current along the limbs of a patient attacked with tetanus, his sufferings may be at least in a great measure relieved."

Asphyxia. (Suspended Animation.)—In all cases of asphyxia, whether proceeding from strangulation, drowning, narcotic poisons, the inhalation of noxious gases, or simple concussion of the cerebral system, the use of galvanic electricity may be resorted to with hopes of success, care being, however, taken not to neglect other modes of resuscitation. In all such cases, the inter-

rupted current should be resorted to; the battery should be pretty powerful, and care should be taken that the electricity should be confined as much as possible to the nerves, and that it be sent along them in the direction of their ramifications. The chief object in asphyxia being to restore the circulation of the blood and the respiratory movements, the galvanic influence should be principally directed to the organs upon whose actions these depend; and towards accomplishing this, no plan appears more likely to be efficacious than that which has been recommended by Dr. Ure, and which we have described at full in the fifth chapter. We allude to the transmission of the current along the *par vagum*.

In asphyxia produced by concussion of the brain, there are strong reasons for believing that galvanism would prove extremely successful. This plan of treatment was first proposed by M. Goudret,* who had his attention particularly called to the subject by witnessing the death of an individual in the Ukraine, who had fallen on his head from his horse, notwithstanding the sedulous application of all the analeptic means familiar to the physician. Upon his return to Paris, he undertook an experimental enquiry into the efficacy of the pile in such cases, and found his expectations more than verified. In his first experiment, a rabbit which had been to all appearance killed by a few violent blows inflicted with the back of the hand, was perfectly recovered by a succession of shocks continued for half an hour, transmitted between the eyes, nose, and meatus auditorius externus on the one hand, and different parts of the spine of the animal on the other. In a second trial, made with a stronger rabbit, the method just described did not produce the desired effect within the space of thirty minutes; but upon removing the cuticle from the spine by caustic ammonia, and then applying the pile as before, at the end of the second half-hour the animal was restored to life, though it continued paralytic for a few days in its hinder extremities. Similar experiments have been performed by Dr. Apjohn with like success.

* Journal de Physiologie, vol. iv. p. 332.

In asphyxia by drowning, it is a remedy which should be resorted to. In a note appended to the communication of M. Goudret, above referred to, Majendie states that he, Panillet, and Roulin had repeatedly succeeded in recovering, by means of the pile, rabbits asphyxiated by submersion in water for more than a quarter of an hour; and adds the important remark, that patience on the part of the operator is indispensable, inasmuch as in cases finally successful, reanimation was not often achieved for full thirty minutes. These results forcibly illustrate the value of Galvanism in the treatment of persons recently drowned; and it would appear advisable, according to the recommendation of Dr. Ure, that a Voltaic battery should be included amongst the means of resuscitation provided by the Humane Society.

In asphyxia from irrespirable gases, and poisoning by narcotic drugs, there can be little doubt that the pile would prove equally useful as a stimulant. Experiments performed upon the lower animals justify this conclusion, though galvanism is not usually mentioned by toxicologists amongst the means to be resorted to.

In sanguineous apoplexy, Dr. Wilson Philip suggests that galvanism might be used to enable the "lungs to perform their functions for a longer time than without this aid," and that thus the life of the patient might be prolonged.

In *Chronic Rheumatism*, there are very many instances of success attending the application of electricity. In the work of Mr. Carpue, already cited, a great number of such cases are recorded. The usual application is by sparks for ten or fifteen minutes every day. In recent cases, a few days sometimes suffice, but in those of long standing, very considerable perseverance is often required. The operation of electro-puncturation has been often employed successfully in such cases. While speaking of this operation, it may be well to observe that, from the reports of its application in the Hospital St. Louis, by Cloquet, it would appear to be a most powerful means of combating morbid action. The diseases in which it has been found efficacious are, the different forms of rheumatism and neuralgia (in the latter affection, the needles should be

inserted in the course of the principal nerve, and the galvanic current transmitted in the direction of its ramification) next in spasmodic affections, as muscular spasm, hysteria, and traumatic trismus; convulsive hiccup and vomiting; periodic epilepsy, preceded by pain in the mammæ; and lastly, in inflammatory attacks, such as contusions attended with extravasation and great pain upon motion, ophthalmia, pleurisy, carditis, and even erysipelas. It has also been used with success, in promoting the absorption of the fluid in ascites; and Carraro has proposed it for the treatment of asphyxia. In paralysis, it is admitted to be of little use, except for relieving the pain, which is frequently the most distressing accompaniment of such disease. Mr. Bourgeois has also proposed electro-puncture of the heart, to promote resuscitation in asphyxia. Admitting the efficacy of electro-puncturation in all these complaints, it is very difficult to form any plausible hypothesis as to the manner in which it acts: some theories have indeed been hazarded on the subject; they are however so vague, contradictory and unsatisfactory, that it would be a complete loss of time to enter upon an examination of them.

In *Stiffness* and *Rigidity* after sprains and bruises, when all inflammation and tenderness have subsided, electricity, in the form of sparks and shocks, has also been applied with success; it usually however, requires some perseverance to complete the cure. In *contractions*, depending upon the affection of a nerve only, electricity may prove of service. According to the experience of Dr. Carpue, electricity has been in many such cases employed without effect, while in others of long duration, immediate relief has been obtained.

In *Chorea*, (*St. Vitus' Dance*) and some other similar disorders, the employment of Electricity, in the form of friction or slight shocks in the course of the spine and limbs, is frequently attended with marked benefit, and we have the authority of Drs. Addison,* Pereira,† and Golding Bird,‡ as to its beneficial tendency.

* Guy's Hospital Reports, vol. ii. p. 493.

† Elements of Materia Medica, vol. i. p. 40.

‡ Guy's Hospital Reports, vol. vi. p. 14.

3. TO PROMOTE SECRETION.

In *Amenorrhœa*, considerable benefit is obtained by passing shocks through the pelvis, from the sacrum to the pubis. Dr. Pereira states that he has, in many cases, found the practice successful. In the "Dictionnaire des Sciences Médicales," there are recorded two cases of this nature. In the former of these, the patient was seventeen years of age, and had been suffering for eighteen months; she was also subject to spasms, which attacked her periodically. Menstruation was restored after the fourth application of electricity, and for two years afterwards remained perfectly regular, at the end of which time she married. The second case was that of a patient only fifteen years old. She was electrified for six months, at the end of which time, menstruation was restored. From the length of time, however, which elapsed, it appears doubtful whether her restoration to health is to be attributed to electricity.

Electric friction or slight shocks have also been proposed for the promotion of *biliary action*, but there are at present no authenticated cases of its efficacy.

4. TO PROMOTE ABSORPTION.

In *Indolent Tumours*, electricity is often employed in the form of sparks, slight shocks and friction. Mr. Carpue states that he has met with many cases which have thus been relieved. The most numerous cases recorded by him, are those of schirrous testes, and he relates some instances of the successful dispersion of schirrous indurations of the breast. He adds that ganglions have also been removed frequently from the wrists or feet, by the application of sparks. Dr. Pereira has tried electricity in several cases of enlarged cervical glands, without observing any benefit resulting therefrom.

Chilblains.—Mr. Carpue states that electricity is a good preventive against chilblains, and mentions two instances in which they were removed by the action of electric sparks.

Having thus enumerated those cases in which the application of both Common and Voltaic electricity may be applied to

produce relief, we shall conclude this chapter, by referring to the maladies in which Voltaic Electricity alone, is likely to prove advantageous.

In *Asthma* and *Dyspepsia*.—Galvanism, in the form of the continued current, has been strongly recommended by Dr. Wilson Philip for the treatment of indigestion, and what he calls habitual Asthma, that is, simple difficulty of breathing, unaccompanied by pulmonary spasmodic action, or any tendency to thoracic action. This application of Voltaic Electricity suggested itself to him, from his having observed in the course of the experiments we have already related, that, after the excision of portions of the par vagum, a current of electricity not only restored the digestive process, but also removed the difficulty of breathing. He describes the benefit obtained, as greatly exceeding his expectations. His method is, to apply a disc of silver to the nape of the neck and another to the epigastric region, and then to press the positive wire of a galvanic battery against the former, and the negative wire against the latter; the circuit is to be maintained until decided relief is experienced, which usually occurs within from five to fifteen minutes. In every instance, a suspension of the dyspnoea was thus effected, and in many cases the cure was permanent. The success which Dr. Philip experienced in his treatment of habitual asthma on this plan, led him to peculiar views respecting the pathology of the affection. The disease, he conceives, to consist in some impediment residing in the nerves, to the transmission from the brain of galvanic influence; and the artificial electric current he supposes to operate by removing such impediment.

Of the proposal to electrolyse *Urinary Calculi*, as also of the *Galvanic Moxa*, we have already spoken. Pravaz* has proposed to cauterize the bites inflicted by rabid animals by galvanic agency, and the principle on which he acts is as follows:—If the connecting wires of a common pile be made to touch a cut or ulcer, within a short distance of each other, the animal fluids undergo coagulation, and by properly shifting these wires, this

† Revue Medicale, Decembre, 1840.

effect may be extended to the entire surface. With a powerful battery, the effect resembles that which would be produced by a solution of nitrate of silver, containing about five grains of the salt to an ounce of water; and with a still more powerful battery, such for example, as ten pair of Grove's, the action is much more intense, and there is almost immediately formed an eschar of very considerable thickness. M. Pravaz details several cases in which this practice was resorted to in the cases of bites inflicted by rabid animals, in one of which, the cauterization was not had recourse to until fifty-four hours after the reception of the bite: the eschar was usually detached on the eleventh day, and the cicatrization completed on the seventeenth.

To coagulate the blood within an Aneurismal Tumour.—On the same principle as the former application of Galvanic Electricity, viz.—the coagulation of the animal fluids which contain albumen; it has been suggested, that Galvanism might be applied to the important purpose of coagulating the blood within an aneurismal tumour, and thus removing the disease, without resorting to the ligature. For this purpose, two needles are to be introduced into the tumour, and their projecting extremities connected with the poles of a Galvanic battery. Although this proposition is ingenious, we are not aware of its having been resorted to.

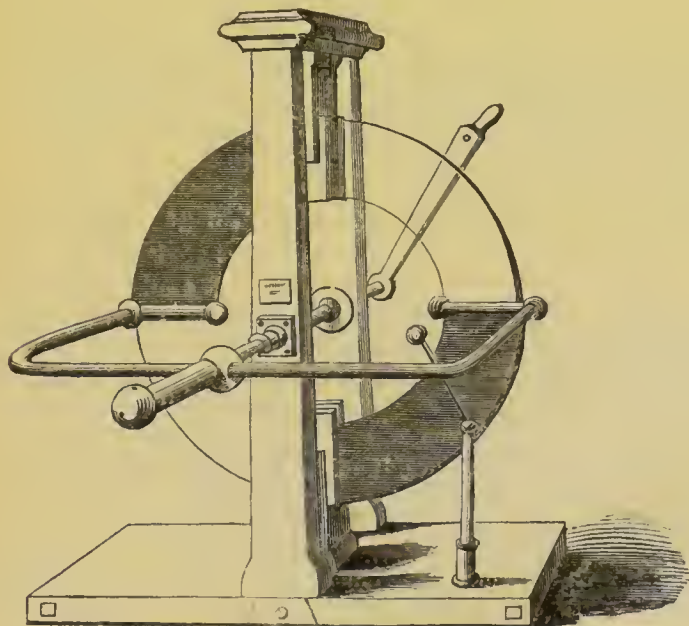
There have been many other propositions in connection with the therapeutic use of Voltaic Electricity. Indeed, there is scarcely a disease, or form of disease, in which some attempt to produce relief by Galvanism has not been made; and it is this empirical use of the remedy which contributes, to a great extent, to throw discredit on an agent which both has and will effect much good. We have, however, confined ourselves in this and the preceding chapters, to those cases where, either from theory we should be disposed to conceive that benefit might result from its use, or where success has really attended its exhibition. To have related the cases themselves would have been impossible within the limits we have prescribed to ourselves; and we have therefore been content to subjoin references to those works in which they were originally reported.

CHAPTER IV.

APPLICATION OF FRICTIONAL ELECTRICITY.—
APPARATUS REQUIRED, AND METHOD OF USE.

It would indeed be a work of supererogation to enter into a minute detail of the form and appearance of instruments so well known as the Electrical Machine and its appendages. We shall therefore simply confine ourselves to a few remarks concerning the apparatus most adapted for medical purposes.

The machines employed for medical purposes should have sufficient power to furnish a constant stream of strong sparks; for in many cases, as will presently be seen, an application of that kind is essential. If it be a Plate Machine, as represented Fig. 1, the diameter of the plate should not be less than from

Fig. 1.

18 inches to 2 feet; if it be a cylinder, Fig. 2, the diameter may be from 8 to 14 inches.

Fig. 2.

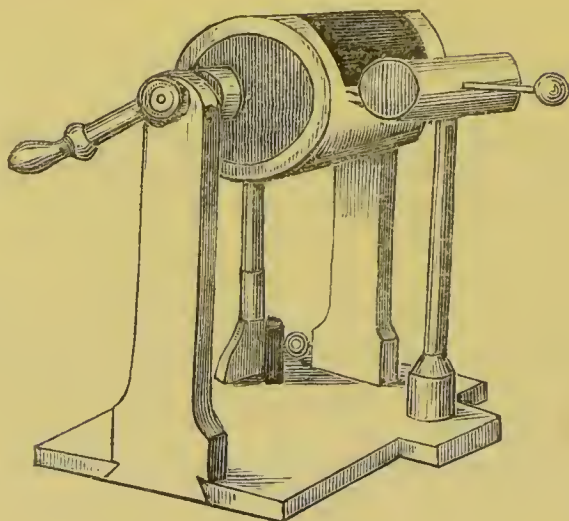
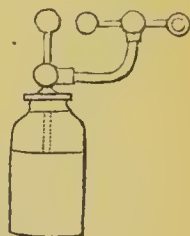


Fig. 3.

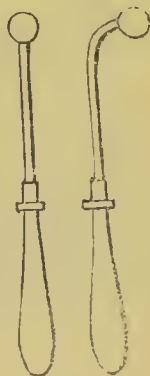
The auxiliary apparatus is very simple; the most essential instruments are,—

First, a Leyden Jar, fitted up with a Lane's Electrometer, Fig. 3, by which shocks of any required force may be given.



Secondly, a pair of Directors, Fig. 4. Occasionally one of the brass balls may be unscrewed, and a wooden point substituted for it. When shocks are applied by the aid of these directors, they are placed at the opposite extremities of the part through which the charge is to pass; and being respectively connected by conducting wires or chains, the one with the outside of the jar, and the other with the receiving ball

Fig. 4.



of the Lane's Electrometer, previously placed at the required distance, the jar may be set to the machine, which is then put in motion until any required number of shocks has been given.

The insulated director is employed also to give sparks, being held by its glass handle, and its ball previously connected with the conductor of the machine by a flexible wire, being brought near the patient, or rubbed lightly over a piece of flannel or woollen cloth, laid on the affected parts. When the eye or any delicate organ is electrified, the ball of the insulated director is unscrewed, and the wooden point applied at the distance of about half an inch from the part. The stream of electrified air, which passes from the point under such circumstances, produces rather a pleasant sensation. Very excellent flexible conductors for medical purposes, may be made by sewing a thin spiral brass wire (such as is used for braces) within a thick silk riband.

The insulating stool employed, should be of sufficient size to receive a chair upon it, with a resting-place in front of the chair for the feet. The patient being placed on the insulated chair, and connected with the conductor of the machine, becomes a part of it, and sparks may be drawn from any part of the body by a person who stands on the ground, and presents either his knuckle or a brass ball to it. If the ball be held by a wooden handle, the sensation is less painful than when it is held by metal.

As a remedial agent, Frictional Electricity may be employed in five different ways:—

The first of these is the *Electric Bath*. In this method the patient is placed upon the insulating stool in connection with the prime conductor, and the machine put in motion. His whole body becomes positively electrified, and the electricity continues to pass silently away. The Electric Bath was strongly recommended by Priestley, under the impression, still generally entertained, that the animal functions are, under such circumstances, discharged with increased vigour, particularly the circulation of the blood and the cutaneous secretion. Such effects are sometimes observed, but by no means invariably.

Electric Sparks.—The next and simplest method of applying electricity to the cure of diseases, is to present the member, or part affected, to the prime conductor of the machine, and thus cause it to receive a succession of sparks; or what is more convenient, to place the patient on a chair, and convey to him the sparks by means of a director connected with the conductor by a chain.

Insulation and Sparks.—The third mode consists in placing the patient upon an insulating stool, putting him in connection by means of a chain or metallic rod, with the prime conductor, and drawing sparks from the seat of disease or pain, by simply presenting to such part the knuckle, or should the operator prefer it, an insulated director connected by a chain with the ground. This method of operating has the advantage over the preceding, that it conjoins the electrical bath with the influence of the spark. It is therefore that usually adopted in the medicinal administration of electricity. The force of the spark is proportionate to its length; so that, by properly diminishing this, its strength may be reduced to any required standard.

A favourite method with some practitioners of applying sparks is to *give* or *draw* them across flannel. For this purpose a director, terminated by a large ball, which is to be covered with a fold of flannel, is approached in the usual way to the organ to be electrified. Instead of a single, strong spark, a series of weak ones will thus be produced, which, emanating at the same instant from several of the woollen fibres, extend over a considerable surface, and produce in it a peculiar pricking sensation. The ball of the director may be naked, the flannel being laid on the part of the body which is to be submitted to the influence of the sparks. This method is supposed to be particularly suited to the treatment of rheumatism and paralysis, especially in patients who cannot endure the stronger forms of electricity.

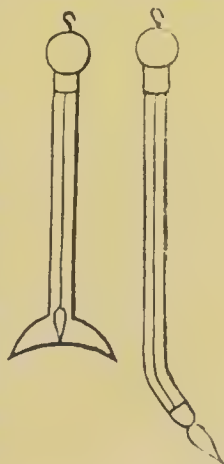
The Aura.—The next form of electricity to be noticed is the Aura, or jet of air which proceeds from an electrified point. This is the modification of the electric influence to which ulcers, excoriated surfaces, and delicate organs, such as the eye and

testicle, are usually subjected. The common method of employing the aura is to present a pointed director, connected by a chain with the conductor of the machine, and held by a glass handle, to the part affected. The particles of air in contact with the point are highly electrified, and immediately repelled. The same occurs to those which take their place, and so on in succession, producing a current of highly excited air, which is, as has been just described, directed upon the organ which is to be treated.

When the point which terminates the director is of baked wood, which, as is well known, is a bad conductor of the electric fluid, the electricity does not issue in a stream as in the former case, but as a succession of sparks, exceedingly minute, which produce in the part of the body upon which they are directed, a sensation perfectly similar to that which attends electrization across flannel. This kind of electricity is applicable to cases where the aura is not sufficiently energetic, and, where the sparks proceeding from a ball are found too pungent.

When it is required to apply electricity to deep-seated parts, such as the interior of the mouth, or the bottom of the external meatus of the ear, a particular form of director has been devised. It consists, as is shown in the accompanying diagrams, Fig. 5 and 6, of a glass tube of about one-tenth of an inch internal diameter, open at one end, and closed at the other by a cork, through which is made to slide a brass wire terminated within by a small ball. To apply this instrument, the open end of the tube is introduced into the cavity, and the internal extremity being brought as near to the affected part as may be deemed advisable, sparks, or the aura, are communicated in the usual way. The glass tube, from its non-conducting properties, prevents any lateral divergence of the electric fluid, and directs it upon the point placed immediately beneath its orifice.

Fig. 5. *Fig. 6.*



Shocks.—The last method of applying common electricity as a remedial agent, is by means of shocks. The method is simply to discharge a Leyden jar through the affected part or member, as may be considered advisable. The easiest method of accomplishing this is, to twist a thin wire round the exterior coating of the jar, and having charged it, to bring the wire in contact with one end of the course it is intended to traverse, and the brass knob of the jar to the other end. Against this method, however, the objection lies, that we are not enabled to measure the amount of the charge; to attain this object, it is necessary to interpose a discharging electrometer in the circuit. The knob of the jar being now placed in contact with the conductor of a machine in motion, and at the selected distance from one of the balls of the electrometer, the discharge takes place so soon as the free electricities have acquired sufficient tension to force their passage through this interval, and a shock is felt in the part of the body which completes the circuit. If this be too strong, the ball of the electrometer must be placed at a less distance, and vice versa. The two parts of the body between which it is intended that the electricity shall pass, are to be touched by the balls of two separate directors, held by an assistant, and connected by means of chains, the one with the electrometer, and the other with the outer surface of the jar. Thus, if one of the directors be in contact with the hip, and the other with the knee, when the discharge takes place, the shock will be felt along the entire thigh. The above described method of regulating the shock, should be familiar to such as employ electricity in the practice of medicine. The discharge of a small jar proves fatal to the smaller animals; and there can be no doubt that by means of a battery of no very great surface, human life might be destroyed. The power too, of sustaining the shock, is very different in different individuals, and even varies in the same person, so as to differ at different times and in different states of the system. These circumstances enjoin caution in the administration of electricity, particularly by means of the jar; and it may be added that its injudicious and indiscriminate use has proved extremely injurious.

“ In the employment,” remarks Dr. Apjohn,* “ of electricity as a curative agent, there are certain precepts to be borne in mind, without an attention to which, disappointment will often be experienced, and unmerited discredit thrown upon a really efficacious means of subjugating morbid action.” These may be reduced to the following heads:—

1. Electricity should only be considered as auxiliary to other modes of medical treatment, which experience has shewn to be advantageous. Thus, in rheumatism, it may be combined with diaphoretics; in chorea, with tonics; and in paralysis, with medicines which, like strychnia, stimulate the nervous system; a practice which has also been adopted for the cure of palsy, arising from the absorption of lead.

2. We should always commence with its weaker forms, such as the bath or aura; next proceed to sparks; and finally, should these prove insufficient, to shocks, taking care to regulate their strength by the means already described, and avoiding their exhibition when of such degrees of energy as to prove distressing to the feelings of the patient. The sparks applied in amaurosis, or for the discussion of glandular swellings, must be feeble, and in such cases, shocks are quite inadmissible. To communicate the latter, a jar, four inches in diameter and six in height, will be found amply sufficient.

3. The electrization should be performed daily, and be persevered in for at least a month, if necessary; and a cure must not be despaired of because there is no immediate relief experienced; for the good effects of electricity generally require a long time for being developed.

4. The *Aura* may be applied for from five to ten minutes. The number of shocks passed in one direction should not exceed twelve, nor the number of sparks twenty-four.

5. In local affections, the electric fluid should be confined to the diseased part or organ; but in diseases such as chorea and epilepsy, in which the entire system seems to be engaged, it must be applied generally over the body; such parts, however, as are affected with pain or any unusual sensation, should be particularly dwelt on.

* Cyclopædia of Practical Medicine, vol. i. art. Electricity.

CHAPTER V.

APPLICATION OF GALVANISM—BATTERIES AND
THEIR USE—ELECTRO-MAGNETISM—MACHINES
AND THEIR USE—MAGNETO-ELECTRICITY.

The discharges of a galvanic battery and a Leyden jar produce effects so analogous, as to render it probable that they affect the living body in the same way, and that they may, therefore, be indifferently applied as stimulants to the nervous system. The voltaic pile, however, possesses many advantages which do not belong to the electrical machine: the quantity of electricity it sets in motion is vastly greater, a peculiarity which may probably confer upon it a higher degree of medicinal power; there is no difficulty in bringing it into action in any kind of weather; the shocks it gives may be more exactly graduated, and admit of being directed with facility to organs which it is difficult, if not impossible, to subject to the influence of the common electric spark; as, for instance, in cases of deafness, gutta serena, amaurosis, and aphonia.

Whenever galvanism is intended to produce an exciting effect, it must be exhibited so as to produce shocks, or in the form of the interrupted current. In asphyxia, for example, the chief object is to restore the circulation of the blood and the respiratory movements. The plan adopted by Dr. Ure, and which has been found the most efficacious, consists in laying bare the sheath which encloses the *par vagum* and great sympathetic nerve, touching it with the wire connected with the positive pole of a battery, and while one extremity of the negative wire is pressed under the cartilage of the seventh rib, drawing the other along the upper edges of the plates of the trough towards its copper or silver end. This plan is very efficacious, and is much more readily arranged than any contact-breaking apparatus. In this way, a rapid succession of discharges, each succeeding one of which exceeds the preceding one in intensity, is sent to

the lungs, the heart, and the diaphragm, that is, to the organs whose functions we are anxious to revive. The same method of manipulation may be employed in all cases where the interrupted galvanic discharge is requisite, that is to say, where it is desirous to stimulate the nerves to increased action, and where, by the practitioner, it may not be deemed advisable to have recourse to the electro-magnetic coil machine, presently to be described.

Whenever galvanism then, is intended to produce an exciting effect, it must be exhibited so as to produce shocks, or in the form of the interrupted current. There are however, certain affections, in which it is conceived most beneficial when flowing in a continuous stream; the specific effects of it, when thus applied, being supposed of a sedative kind. This opinion of the difference of action of the voltaic pile, in the two conditions of it just described, does not rest upon mere conjecture; it is based upon the observations of medical electricians, and upon the experiments of Nobili and others which we have already detailed. It is generally thought that convulsive affections, not excluding tetanus itself, may probably admit of being controuled by galvanism; but that in these, the method of administration should be the opposite to that for paralysis; or that instead of the interrupted, the continued current should be resorted to; and that to obtain the maximum tranquillizing effect, the electricity should be transmitted along the nerves, in a direction contrary to that of their ramifications.

In the therapeutic administration of galvanism, the feelings of the patient must be our guide as to the strength of the charge which should be employed in each particular case; some will sustain with impunity the shocks of a battery which would prove most distressing and injurious to others; the dose may be graduated to any required degree of nicety, by properly varying the interval between the conducting wires, for upon this, with a given machine and exciting fluid, will depend the degree of energy of the developed electricities; the strength, in fact, of the galvanic shock, depends not so much upon the size, as upon the number of pairs which compose the battery; the power too of the batteries, will depend much upon the strength

of the acids employed, as will be seen in the subsequent part of this chapter. The wires used for completing the circuit, should be furnished with insulating handles composed of glass, and be armed at their free extremities with balls of brass, or what answers better, of silver, gold, or platina; should such be wanting, silver discs (shillings will answer the purpose well) should be laid upon the parts between which the current is to be made to pass, their position being occasionally changed, to prevent the skin beneath from being injured. The subjacent cuticle also, being a non-conductor, should be moistened with a solution of sal-ammoniac, common salt, or vinegar and water.

In concluding this part of our subject, we shall subjoin a recapitulation of the general principles of practice laid down by a celebrated modern writer, Dr. Apjohn.*

“ 1. Feeble powers should always be first tried; these should be gradually augmented, and the use of such finally persisted in, as, without producing any violent effects, appear to make a decided impression on the disease.

“ 2. Galvanism as a remedial agent, must not be hastily given up because of its beneficial effects not immediately appearing, for these, generally speaking, require considerable time to be developed.

“ 3. The pile should not be relied on exclusively in the treatment of diseases, but should rather be considered as auxiliary to other methods of cure.

“ 4. To the preceding we shall add, that in cases where the continuous current may be deemed most advisable, it would be well to resort to machines composed of plates having an extended surface, there being reason to believe that the curative influence of galvanism in this form, depends not upon its intensity, but upon the quantity of it set in motion.”

To these principles we may add, that in all cases where it is necessary that the interrupted current should be administered, the electro-magnetic coil machine will be found much more manageable, much more portable, and equally powerful, if not

* *Cyclopædia of Practical Medicine*, vol. ii. art. Galvanism.

more so, than the galvanic battery itself. The various forms of this instrument will be described at the end of this chapter. In cases where the continuous current is required, the battery alone can be used.

VOLTAIC BATTERIES.

It will be seen from what has been said, that, for the due application of Galvanism as a remedial agent, it is essential to have a full understanding of the construction of Batteries and their manipulation.

The first of these instruments which we shall describe is that represented in Fig. 7, known as *Cruikshank's Battery*. It consists

Fig. 7.

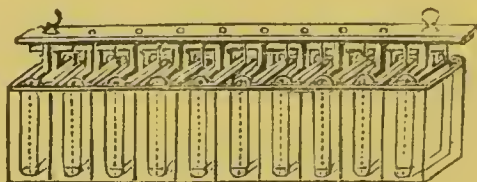


of a series of pairs of zinc and copper plates fixed into a trough of wood, and may be excited either by dilute sulphuric acid, or by a solution of sulphate of copper, which latter, as Dr. Fyfe* has shown, increases the electro-chemical intensity of the electric current. This form of apparatus is neither so convenient as, nor does it possess the power of, the modern arrangements which we shall presently describe; but as many such instruments are still in use, we have deemed it necessary to make mention of it. The battery of Dr. Babington is formed on the same principle as the preceding, with the exception that the plates of copper and zinc, usually about four inches square, are united together in pairs, by soldering at one point only, and are excited by immersion into a trough of earthenware, divided into ten or twelve equal portions, and filled with dilute sulphuric acid. In both these batteries the liquid should consist of about one part acid to fifteen or sixteen water. The plates are attached to a strip of wood, and so arranged that each pair

* London and Edinburgh Philosophical Magazine, vol. xi. page 145.

shall enclose a partition between them; by this means the whole set may be at once lifted into or from the cells; and thus while the fluid remains in the trough, the action of the plates may be suspended at pleasure. The form of this battery is represented in the annexed diagram, Fig. 8. A further im-

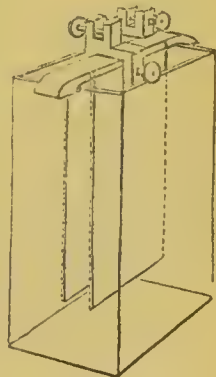
Fig. 8.



provement in this form of battery was made by Wollaston. It consists in doubling the copper plate, so as to oppose it to both surfaces of the zinc, while the contact of the surfaces is prevented by pieces of wood or cork placed between them. Ten or twelve troughs on this construction form an efficient Voltaic Battery.

Smee's Battery.—Of all the galvanic batteries, however, now in use, it will be found that the combination invented by Mr. Smee, usually known as Smee's Battery, is the most useful for medical purposes. It has the advantage of being tolerably constant, sufficiently powerful for all cases, portable, easily charged, and as easily cleaned. Its general plan is represented in Fig. 9. The battery consists of a plate of platinized silver, connected with a binding screw, and fixed to a beam of wood. A strip of stout and well amalgamated zinc is placed on each side of the wood, and both are held in their place by a binding screw, sufficiently wide to embrace the zinc and the wood. This arrangement is immersed in a cell containing diluted sulphuric acid, made by mixing together one part by measure of sulphuric acid and seven of water. The

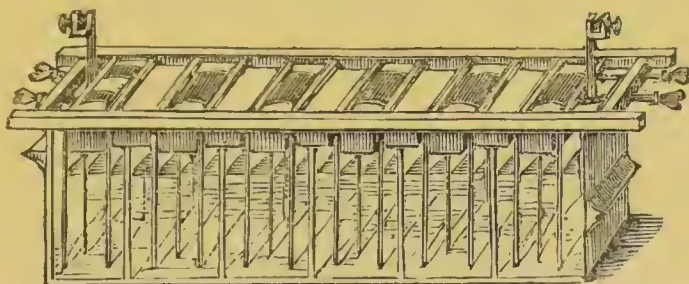
Fig. 9.



operator must be careful that the silver in no place touches the zinc. The arrangement thus immersed will be found to produce no effect on the liquid until a communication is made between the metals, when a violent evolution of hydrogen gas takes place, and an active voltaic battery is obtained. If, however, the zinc be imperfectly amalgamated, or from want of care in the immersion of the arrangement, the silver plate has any portion of its surface in connection with the zinc, an action is apparent. In the former case, it depends on the want of protection afforded by the coating of mercury to the zinc, and may be easily obviated by fresh amalgamation; in the latter it is still more easily remedied by examination, and the separation of the metals wherever they may be in contact. This form of battery is the one usually sold for medical purposes by the publishers of this work.

For intensity effects, Smce's Battery may be arranged as an ordinary Wollaston with advantage, as shown in Fig. 10. Ten or

Fig. 10.

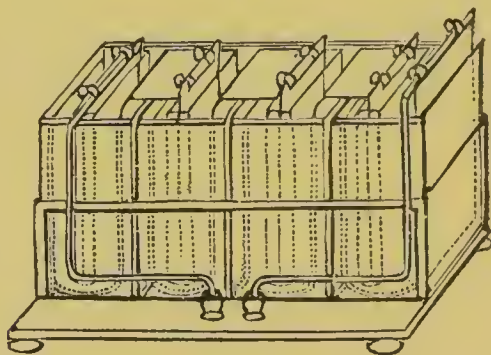


12 form an elegant battery, sufficiently powerful for all medical purposes. This arrangement is a general favourite, and is probably more extensively used than all the other forms put together. It is simple in construction, exceedingly manageable, and elegant in its appearance; and although it is not so constant as that invented by Professor Daniell, nor possessed of the intense energy of Professor Grove's, it has the great advantage of being almost instantaneously set in action, and as quickly cleaned and put aside. Hence its great utility for medical pur-

poses: added to which it may be remarked, that this form of battery gives rise to no unpleasant or noxious fumes, and this must be allowed to be a great desideratum.

Grove's Battery.—Another form of battery which may be employed is that of which we have already spoken, generally known as Grove's Nitric Acid Battery. It consists of a series of porcelain cells or jars, containing slips of amalgamated zinc, in contact with dilute sulphuric acid, of the same strength as that before recommended for the Smee's arrangement. In these jars are placed parallelopiped vessels, made of porous clay, containing strong nitric acid, into which are immersed slips of platinum foil; each slip of platinum is attached by a binding screw to the next zinc plate, so as to leave at the one end of the battery a zinc pole, at the other a platina pole. This arrangement is by far the most powerful voltaic apparatus yet known. The only disadvantage attending its use is the time required for charging it, which, in a case of emergency, such, for example, as asphyxia from drowning or any other cause, must be of the greatest importance. The annexed figure represents the general appearance of this apparatus. Fig. 11.

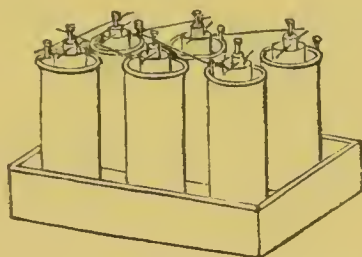
Fig. 11.



The last form of battery which we deem it necessary to describe, is that invented by the late Professor Daniell, and by him termed the *Constant Battery*, (Fig. 12) from its power of continuing

in action for a lengthened period of time. It consists of a cell of copper, which of itself forms the negative metal, containing a tube of porous earthenware of much smaller diameter. Within this porous tube is placed a rod of amalgamated zinc, to which, as also to the copper cell, is attached a binding screw. A cell of this description is excited in the following way :—the porous tube containing the zinc is filled with dilute sulphuric of the ordinary strength, and into the copper cell is poured a saturated solution of sulphate of copper, made by pouring boiling water upon a superabundance of the crystals of the salt of copper.—A perforated metal shelf is fitted to the top of the cell, for the support of a supply of crystals to recruit the exhausted strength of this battery.

Fig. 12.



Having thus described briefly, but we trust, intelligibly, the various Voltaic Instruments in use ; it may be requisite, before dismissing them completely from notice, to make a few remarks on some of the practical points attending their manipulation. In the first place, it is absolutely necessary that the various connections of batteries should be perfectly clean to insure a good metallic contact. If this point be neglected, it will frequently be found, that either the apparatus will not act at all, or at all events be much diminished in power. The interior of the binding screws, or the surfaces where the excited metals are, as in Grove's battery, placed in contact with each other—and the ends of the conducting wires should be perfectly freed from metallic oxides or dirt, by means of sand paper—a very little trouble being sufficient to effect this. The necessity of perfect

metallie contaet being insured by the cleanliness of those portions of the apparatus which require to be in direct connection with each other cannot be too strictly enforced.

Amalgamation of the Zincs.—In the course of this chapter we have had frequent occasion to speak of the amalgamation of zinc, that is to say, the covering zinc with a coating of mereury, to prevent the rapid action which would otherwise take place between the liquid and the metal. For the proper and profitable use of these batteries, it is necessary that this amalgamation should be so perfect, that no action should be apparent until the circuit is completed. The zincs sold at the philosophical instrument makers are generally properly amalgamated; but after some little use, it will be found that the metal requires a fresh amalgamation, otherwise, by the *local action*, as it is usually termed by electricians, taking place between the acid and the metal, the zinc will be rapidly consumed. In an economical point of view, therefore, as well as for obtaining the full power of the battery—(for, however energetic this local action may be, it does not increase in any way the power of the battery, but has a directly contrary effect)—it is advisable invariably to re-amalgamate the zinc the moment any action of this kind is apparent. This is easily effected; it is only necessary to remove the zinc from the battery, rinse it in a little cold water, and to pour on it a few drops of mercury, which will immediately attach themselves to the zinc, and may be rubbed uniformly over its surface by means of a little pad of tow. It requires but little trouble to do this, and the result will in all cases be found amply to repay it.

While on this matter, it may be well to press upon the reader the necessity of invariably cleansing the battery before it is finally set aside. The acid solution should not be thrown away, as it will serve for many operations. It is not until any considerable quantity of sulphate of zinc is formed that the voltaic action is rendered less energetic. The plates should always be thoroughly rinsed in cold water, and set aside to drain. The platinas of Grove's battery should be thoroughly well washed, dried with blotting paper, and kept perfectly smooth until again

required for use. The zines should, as in other batteries, be rinsed and set aside to drain. The detail of these minute points may appear tedious, but it will be found that attention to these matters will prevent disappointment, and the operator will be enabled to insure the proper action of his apparatus.

Of the terms POSITIVE and NEGATIVE.—There is nothing which has a greater tendency to confuse the mind, with regard to voltaic apparatus, than the terms *positive* and *negative* end of a battery. “The fundamental principle,” observes Mr. Walker, “which cannot be too strongly enforced, is, that the passage of the electricity is from the zinc to the copper.” This, of course, refers to the common forms of battery—Cruikshank’s, Babington’s, &c. In the arrangement of Smee, the passage of the electricity is from the zinc to the silver; in Grove’s battery, from the zinc to the platinum. “The positive is the end where the electricity leaves the battery; the negative where it re-enters it. The direction taken by the current being ascertained by the mere inspection of the situations of the two metals in a cell, the other points follow as a necessary consequence.” Now, taking the Smee’s battery as an illustration, it must be clear, that as the electricity passes from the zinc to the silver, it would leave the battery by the wire attached to the silver plate, and having passed through the interposed apparatus, would return to the battery by the wire attached to the zinc plate; the silver, which is the *negative metal*, forming the *positive end* of the battery; and the zinc, the *positive metal*, forming the *negative end*. In like manner with all the batteries we have described, the zinc, though the *positive metal*, is the *negative pole*.

ELECTRIZERS.

There is another method which has been devised for the topical application of Voltaic Electricity, and which, from the name of their inventor, usually pass under the title of *Harrington’s Electrizers*. They are plates of copper and zinc, or silver and zinc, made in different shapes. In tooth-ache, for

example, a plate of silver is soldered by its edge to a plate of zinc, and worn in the mouth, the saliva serving to excite the apparatus, and to produce a voltaic circuit. In another contrivance, a plate of zinc is connected by its face to a plate of silver; and a series of these compound plates are connected together by wire, so as to move on each other like hinges. These are worn next the skin for the relief of rheumatism, the perspiration serving to excite the plates. Silver and zinc spangles have likewise been employed, instead of the plates just mentioned.

ELECTRO-PUNCTURATION,

As it is usually denominated, is performed by inserting, in the ordinary manner, two or more needles into the part or organ affected, and then touching these with the wires from the poles of a feeble galvanic battery, the contact being occasionally suspended and renewed, so as to produce a succession of shocks. It has been chiefly employed by Cloquet, at the Hospital of St. Louis; and from the reports of his friends, Pelletan and Dantes, and from the treatise of the Chevalier Sarlandier, it would appear to be a most powerful means of combating morbid action. The diseases in which it has been successful have been enumerated in a preceding chapter (page 36.)

ELECTRO-MAGNETIC COILS.

There yet remain for description in this chapter, the most recently invented and the most convenient instruments for the application of Galvanism, usually called Electro-Magnetic Coils. The limits to which we are compelled to confine ourselves, preclude us from entering minutely into the experiments and phenomena which led to their construction, and we shall therefore content ourselves with simply enumerating the principles on which their action depends, leaving the reader who may need

further information, to consult the excellent works of Mr. Noad,* or Mr. C. V. Walker,† on this subject.

If a copper wire be twisted in the form of a helix, and a current of electricity be passed through it, it *induces* another current of electricity in any other coil which is in its immediate vicinity. If a small bar of iron, or what is better a bundle of iron wires, be introduced into the axis of the helix, and a current of electricity be passed through the coil of wire, it will be found that the electric spark, and its accompanying snap, are much increased; but it is only on breaking contact with the battery that this effect is produced; the reason is that the iron, magnetised by the power of the continuing current, loses its magnetism at the moment the current ceases to pass, and in so doing tends to produce an electric current in the wire round it.

Mr. Callan, of Maynooth College, was the first who contrived a convenient apparatus for the illustration of secondary currents. A coil of thick insulated copper bell-wire is wound on a small bobbin; and on a large rod, with a hollow axis, in which the bobbin may be introduced at pleasure, a length of about 1500 feet of thin wire is wound; the two coils are thus perfectly distinct from each other, and by sending the current from the battery through the interior coil, the Electricity present in the exterior coil is set in motion by its inductive influence; and from it both physiological and electrolytic effects may be obtained. If 100 yards of fine insulated copper wire be wound on a reel, and contact with an electrometer rapidly broken, shocks may be obtained, by grasping metallic cylinders in connection with the ends of the coil, from the reflex wave of Electricity which is generated; and if a bundle of iron wires be placed in the axis of the helix, the brilliancy of the sparks, and the intensity of the shocks will be greatly increased, in consequence of the second wave of Electricity being, as we have seen, produced at the moment of the demagnetising of the iron.

It is on this latter principle that the greater number of the Electro-Magnetic Coils are constructed. There are many forms

* Lectures on Electricity, by Henry M. Noad. Lond. 1844.

† Second volume of Electricity in Lardner's Cabinet Cyclopædia.

of these instruments; but their principal difference consists in the means adopted for breaking the battery contact, and so giving rise to the secondary current. The form of apparatus which appears to us to be both simple and manageable, is that represented in the accompanying diagram.

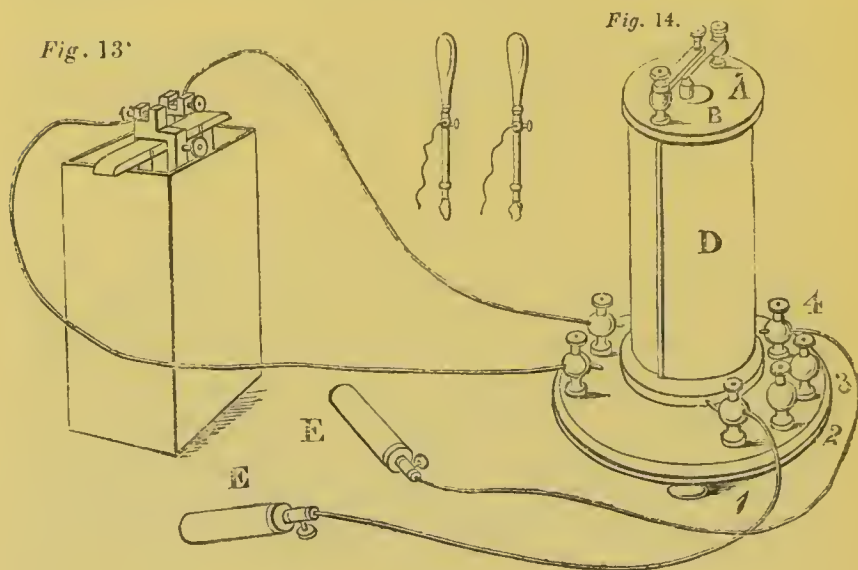


Fig. 14, D represents the Electro-magnetic coil, the construction of which will now be readily understood. It consists of two coils of insulated copper wire; the one internal, which, by means of the binding screws, can be connected with a Galvanic battery, as seen in the figure. This is called the *primary* coil. The other, or *secondary* coil, is placed externally, and is in connection with the four binding screws, marked respectively 1, 2, 3, and 4. In the centre of the primary coil is placed a bundle of fine iron wires, (seen at B,) for the purpose of increasing the intensity of the effect, as already explained. Fig. 13 is a Smec's battery, connected with the Electro-magnetic coil. The moment that battery contact is made, the electricity circulating through the bundle of iron wires renders them magnetic, and they immediately

attract a small piece of iron placed directly above them. This iron is attached to a spring, (A,) so contrived, that the attraction at once and completely cuts off contact with the battery. Two effects are thus produced. The circulation of the electric current through the primary coil gives rise by induction to a current of electricity in the secondary coil, which is also considerably increased by the reflex wave of electricity set in motion by the demagnetising of the iron wires. The electricity thus generated from these combined sources produces all the physiological effects required, giving rise to strong shocks. But the moment the iron is demagnetized, the spring A falls back to its place, and connection with the battery is again established, the wires are once again rendered magnetic, and the same effects follow; the rapidity, indeed, with which the instrument acts is almost incredible.

In the foregoing figure, F, E, are the directors, applicable for the mere transmission of shocks through the body generally; they are intended to be grasped in the hand of the patient. When, however, it is required to transmit the shocks through any affected limb, or to confine them to any organ, the sponge directors, represented above them in the same figure, must be resorted to. They consist of metallic tubes, fitted with insulating handles to protect the operator while administering the shocks. Into the extremities of the metallic tubes pieces of sponge are to be placed, and they are retained in their places by means of sliding rings, with which the tubes themselves are furnished. Close to the handles are binding screws, into which are to be fitted the conducting wires from the secondary coil of the machine. When required for use, the sponges are to be well moistened with some liquid, so as to increase the conducting power; vinegar and water is generally used, as being at hand. The sponge directors are equally applicable for the administration of Galvanic Electricity immediately from the battery.

In the management of the Electro-magnetic coil, it is necessary always to observe that the spring attached to the ball A touches the screw C; at the same time it must not be pressed down so tight as to cause the ball to touch the iron wires in the axis of the coil. According to the power required, the directors

must be fixed to the binding screws; thus, if attached to Nos. 4 and 3, the least power will be given; if to 4 and 1, the greatest. The power may be increased or diminished according to the size of the battery, and the strength of the acid used. These instruments are readily set in action; easily cleaned; very manageable; and as efficacious as any other form of Voltaic apparatus. To the medical practitioner, their portability is not their least recommendation, since they are sold in a neat packing-case, which contains the battery, directors, coil, and all necessary appendages.

We have said that there are other forms of this instrument; but as they differ (with one exception, the Galvano-Therapeuticon, hereafter described,) only in the mode of breaking the battery contact, we do not deem it necessary to occupy more space in details which, considering that the principles upon which they are constructed are essentially the same, would doubtless be considered tedious. We repeat, that all these machines act in the same way, and depend on the same philosophical principles for their action and efficacy. This is a fact which we are the more disposed to impress strongly on the mind of the medical reader, since we are aware that latterly there have emanated statements in direct opposition to this, from many unprincipled venders of such apparatus, actuated only by mercenary motives. Such groundless assertions are but a part of that spirit of charlatanism which arrests the progress of all great truths, or, with reference to new and important remedies, gives rise to incredulity on the part of those who discover the deceit.

GALVANO-THERAPEUTICON.

We now come to the latest and most approved arrangement for medical purposes, viz: the Galvano-Therapeuticon of Mr. Charles Brown, jun. of Woolwich.

This machine bids fair to be far more popular than any of its contemporaries. It is very *efficient, perfectly safe, and of such singular facility of management*, as to render it, in this respect,

incomparably superior to anything of the kind we have seen. The Galvanic current can be so regulated by a beautifully simple method, contrived by the inventor, that the most delicate persons receive it with expressions of approbation and pleasure; an advantage, the importance of which will be appreciated in no small degree by the medical practitioner and Galvanist. Another distinguishing characteristic of this machine is its compactness and elegant appearance, as will be seen by reference to the accompanying sketch.

As the Therapeuticon will speak for itself, its advantages being so obvious, we need say nothing farther to advance its superior claims, other than that, to the most distinguished patronage, is added the unqualified encomium of some of the first men in the scientific world, as the note (which we have taken the liberty to subjoin) from that eminent chemist, James Marsh, Esq. will suffice to shew:—

“MY DEAR SIR,

“I have taken much pains to examine the arrangement of the Therapeuticon, as proposed by your son, and have much pleasure in saying that, in my opinion, it is by far the best form of the apparatus I have yet seen. The method by which any current within the power of the instrument can be readily and instantaneously obtained, and as quickly reduced to a degree scarcely perceptible to the feeling, is, in my opinion, entirely new, and very perfect in its action on the human frame, as I have repeatedly experienced.

“Trusting the instrument will meet with that general use which I consider it entitled to,

“I am, My Dear Sir,

“Yours truly,

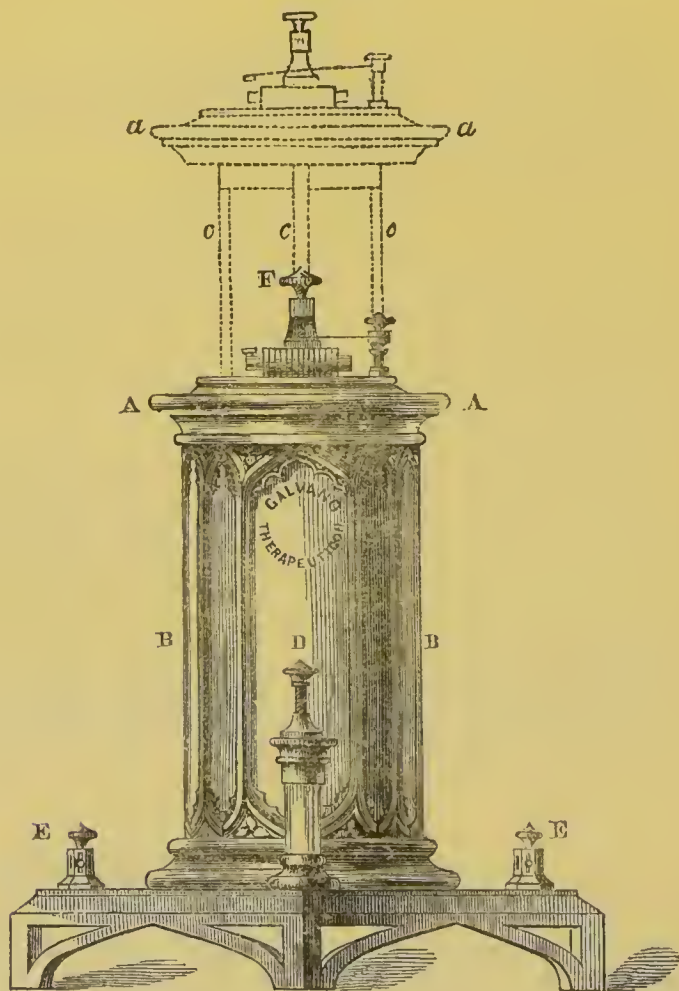
“To C. Brown, Esq. Woolwich.”

“JAMES MARSH.”

To the experience of Mr. Marsh, might be added that of the numerous officers composing the Medical Staff of the Royal Military Hospitals of Woolwich, and of many private practitioners, to the successful employment of Galvanism therapeutically. In the practice of Mr. Brown are very many and highly interesting cases, a selection from which may on some future occasion be given.

The figure 15, together with the instructions for use, will convey a sufficiently correct idea of this beautiful and unique machine, and will prevent the necessity of giving a more lengthened description.

Fig. 15.



DIRECTIONS FOR USING THE GALVANO-THERAPEUTICON.

The top, *a a*, is to be drawn entirely out of the coil *b b*, in order to supply the glass jar within with the acid, to the height of the

red ring marked upon the glass.* The top AA is then to be replaced, care being taken that the guides, c c c, are *all external* to the glass; that is, the plates only are to be in the acid: the guides require a slight compression in thus returning them to their place. The screw D of the regulator is to be turned until the fine point within the glass tube is clear of the coloured water. The conducting wires. The conducting wires are now well secured, one in each binding screw EE: should the vibration under the screw F not be regular and rapid, the screw must be turned higher or lower as is necessary. The operator now taking hold of the handles, and the screw of the regulator D being slowly turned by the operator to meet the coloured water, the current will pass, the strength increasing as the point descends, *et vice versa*.

SUSPENDING OPERATIONS.—The top AA is to be steadily raised to the position shewn by the dotted lines *aa*, when the guides *ccc* will spring and suspend it until again required for use.

Considerable care being necessary in the construction of this machine, we would caution purchasers, in order to avoid disappointment, that in no case can a machine be warranted perfect, unless it has the name and address of the sole manufacturers by appointment, (Messrs. WILLATS, Cheapside, London), conspicuously placed upon it, and having the signature of the inventor upon the label.

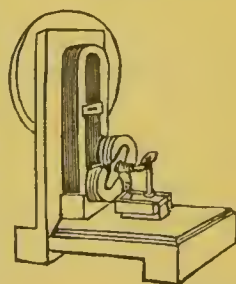
MAGNETO-ELECTRIC MACHINES.

As Electricity, under certain conditions, gives rise to magnetism, so magnetism, in its turn, can be made to evolve electricity. Our celebrated countryman, Faraday, was the first to discover that magnetism conjoined with motion may be made the source of electricity. It would be foreign to a work of this kind, and

* The acid employed is one part of sulphuric acid to eight parts of water. This being once supplied, will last for months, any little loss by evaporation being made up with water.

would carry us beyond our limits, were we to attempt to describe the beautiful experiments by which that philosopher was enabled to prove the fact; suffice it to say, that on this principle have been constructed machines, by which a current of electricity is set in motion without the aid of a battery. The general form of one of these instruments is seen in the accompanying figure. It consists of a horse-shoe magnet, which is fixed to a frame; opposite its poles is placed what is termed the armature, which can be rapidly revolved by means of a multiplying wheel. The armatures are nothing more than electro-magnets, such as we have already described; and by means of the wheel, each pole of the armature is brought in rapid succession opposite each pole of the magnet, and that as nearly as possible without touching; and a most brilliant succession of sparks, forming almost a continuous light, is produced. The shocks from these machines too, are very powerful; but as it is a matter of no inconsiderable difficulty to regulate them according to the necessity of the case, the use of the Magneto-Electric Machines in medicine is very limited.

Fig. 16.



CHAPTER VI.

ON THE DETECTION OF NEEDLES AND OTHER STEEL INSTRUMENTS IMPACTED IN THE BODY, BY ELECTRO-MAGNETS.

BEFORE bringing this little work to a conclusion, it is deemed necessary to draw attention to a most valuable and important application of the principles of electro-magnetism, recently proposed by Mr. Alfred Smee. Every medical practitioner

must have had frequent opportunities of observing cases, in which portions of steel are introduced into the body, in the shape of needles, or as points of cutting instruments: frequently such foreign bodies remain unnoticed, and without producing any mischief for some lengthened time, and ultimately, perhaps, find their way to the surface; a small abscess is formed, and they are thus discharged. But although this is a frequent termination of such accidents, unfortunately it is not the only one; it occasionally happens that they become lodged in a joint; the affected part will swell, suppurate, and discharge; ulceration of the cartilages and osseous tissue supervenes; and the mischief is generally so great as to produce ankylosis. Such a case occurring to Mr. Smee, induced him to turn his attention to the subject. "Some time since," writes Mr. Smee,* "I had a case under my care, where a small portion of a needle was introduced into one of the joints of the finger, but of which no indication existed, beyond the effects which might have been expected from the presence of a foreign body. The exact spot of its insertion was unknown, and indeed, it was equally uncertain whether it was inserted or not. Subsequently, the joint swelled, suppurated, and discharged, and a small piece of needle was found firmly impacted in the bone. Now a very small piece of foreign matter is capable of producing such disastrous results, and on having weighed the piece discharged in this case, I found that it scarcely amounted to the seventh of a grain. Now it occurred to my mind that, had I known that the needle was actually present, and could have demonstrated the exact spot, I might have possibly averted the present inconvenience of a stiff joint to the unfortunate sufferer; and after having carefully considered the matter, a plan suggested itself to my mind for the detection of needles in future cases."

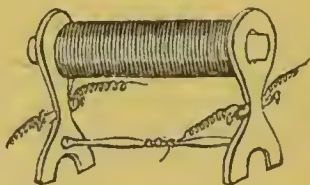
The plan by which Mr. Smee proposes to remedy such accidents, depends upon the well-known fact, that steel may, in many ways, be rendered magnetic;—thus, by the approximation of a powerful magnet, by the circulation of a current of electri-

* Reported in the Medical Times.

city around it or in its immediate vicinity, it evinces magnetic properties. Now one of the most important properties of a magnet is, it will be remembered, that its north pole will repel the north pole of another magnet brought near it, but attracts its south pole, the converse being the case with regard to the south pole.

These facts being known, the principle on which Mr. Smce acts is readily understood. The first point is to render the suspected piece of steel magnetic. The mode of effecting this may be best described in the words of Mr. Smce:—"When you suspect the presence of a piece of needle, or other steel instrument, you must subject the suspected part to a treatment calculated to render the needle magnetic; and this is best done by electro-magnetism. I have tried many forms of instruments, but should prefer that represented in the accompanying diagram, which is made of a simple bar of soft iron wound round with wire. The iron has a plate of brass, *B*, fixed in both ends to retain the wire (*w*) in situ; and the two ends of the wires are attached to binding screws (*s*).

Fig. 17.

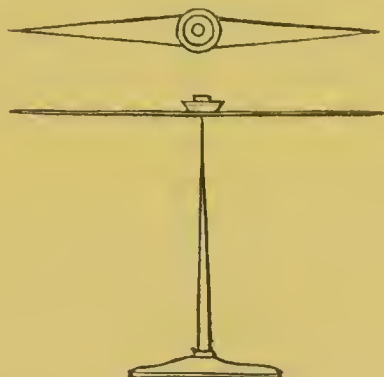


When this instrument is connected with the poles of a voltaic combination—(and for this purpose any battery possessing sufficient power may be employed, as, for example, a single cell of Grove's or Smce's already described)—it is to be kept in close approximation with the suspected part for some little time, and if there be a portion of steel conveyed therein, it will be endued with magnetic properties.

To test the existence of the magnet within the body is the next point necessary, for which purpose a common sewing needle previously rendered magnetic, and suspended by a portion of silkworm's silk, may be employed. But it will be found that the most convenient apparatus for the purpose is such as is represented in the diagram. (Fig. 17.) It consists of a delicate needle, about six inches long, centred upon a small agate cup

resting upon a steel point, so that the smallest possible amount of resistance is offered to its free play.

Fig. 18.



When a part containing magnetic steel is brought near the needle, it may be either attracted or repelled; it may move upwards or downwards; or it may exhibit disquietude according to the position in which the new magnet is held. We may detect the position of the foreign body, when it is of any size, by ascertaining where its north and south poles lie; and these are determined by their repelling and attracting the opposite poles of the magnetic needle. The disquietude, or motion upwards and downwards, merely indicate magnetism, but not the direction of the magnet. Mr. Smee has had more than one opportunity of proving the practicability and efficiency of the plan. In one instance, he succeeded in detecting a piece of needle impacted in the finger of a young woman, although, upon removal, it weighed but the seventh part of a grain. It gave such marked indications, that he was enabled to ascertain tolerably well the positions of its north and south poles, and consequently its exact situation.

In performing these experiments, it is necessary to be careful to continue the voltaic current in the same direction; for if it be reversed for one instant, it would tend to demagnetise the previously magnetised steel.

In bringing this little work to a conclusion, the author can only venture to express a hope that his efforts to draw attention to the advantage which, in many cases of disease, may be derived from Electricity in some of its modifications, have not been altogether fruitless. The science is, we believe, but now in its infancy, and it is not improbable that future discoveries may place in our hands a still greater opportunity of alleviating human suffering. It must be remembered, however, that it is only by constant experiment, by untiring research, that we are likely to be made acquainted with such results.

APPENDIX.

SINCE the foregoing pages were printed, our attention has been drawn to some further application of electricity, the results of which appear to us of much importance. Dr. Radford, of Manchester, was the first who suggested the application of Galvanism in *Uterine Inertia*, and the success which attended its use in his hands, has been amply confirmed by other practitioners. In the Lying-in Charity of Guy's Hospital it has been on many occasions had recourse to with the most marked advantage. A case of this nature was published some short time back ; and as it tends to show when the application of galvanism is indicated, we subjoin it entire in the words of the author, Mr. F. W. Cleveland.

“ I was requested to see Mary Cook, æt. 39, in her sixteenth confinement, on Friday morning, the sixth of June. On my arrival at the house, I learned that her previous labours had been tolerably good, with two or three exceptions, when they had been considerably protracted from want of pains. Her health has always been delicate, and for the last few weeks she has had a troublesome cough, attended with copious expectoration ; emaciation and occasional night-sweats—symptoms which naturally led to the opinion that she was suffering from phthisis, although subsequently this diagnosis was not confirmed by a physical examination of the chest. On the Sunday evening prior to my visiting her, she was first attacked with premonitory symptoms of labour, soon succeeded by regular and frequent pains, which, on the following morning, abated, but never entirely left her till the Wednesday night, when the liquor amnii was discharged. At one A.M. on the Friday, the pains

returned with considerable vigour, but did not last above an hour, and at six were again renewed for a short time. It was about four hours after this period that I found Mr. T. with the patient, to whom he had given a dose of the tincture of ergot, and also some spirit and water; but these measures were followed by only a few slight and ineffectual pains.

“ On making an examination, I found the vagina freely lubricated, the os uteri dilated, the head of the child small, presenting in the right oblique diameter, and in the pelvic cavity; in fact, there appeared no obstacle whatever to the completion of the case but uterine inertia, which I considered was owing to constitutional debility, arising chiefly from the state of the chest. She had now rather an anxious countenance, a small and frequent pulse; complained of great thirst and languor, and of having had no sleep for several nights.

“ It was obvious that if uterine contraction could not be somehow induced, and it must be remembered that the ergot had been already tried, the alternative would eventually be instrumental delivery; and this, considering the weak state of the patient's health, and the not improbable and unpleasant result of hæmorrhage from atony of the womb, was not desirable. At the suggestion of Dr. Lever, who kindly lent me his electro-galvanic apparatus, I resolved on a fair trial of galvanism, and accordingly, with my friend Mr. Richardson, proceeded to its application externally and obliquely across the anterior surface of the uterus. In a few minutes the effect was very apparent; regular, strong, and frequent pains came on, and in a quarter of an hour from the first application of the remedy, a living male child and placenta were expelled, attended with the least degree of hæmorrhage I ever witnessed. The uterus was immediately firmly and permanently contracted, and, with the exception of slight soreness of the abdomen, the patient expresses herself as quite comfortable, and since that time, setting aside debility, she has progressed favourably.”

In Guy's Hospital, galvanism has been recently applied in a case of *Irritable Stump* after amputation of the thigh. Five or six applications, each lasting about twenty minutes, gave great

relief, and ultimately, from its continued use, perfect ease was obtained by electricity when other means are without effect.

There is one other class of disorders in which electricity seems to be very valuable, and particularly so, as they often resist all other means of cure; viz. those which depend upon *Spinal Weakness*, as shown by loss of power, sometimes and most frequently only in the lower extremities, at others extending to all the muscles of the body. In Guy's Hospital, during the last two years, there have been many cases of this kind. The following is the outline of one:—A male patient, aged forty years, had lost power in the lower extremities, probably from working in a damp situation; he was too weak to walk without being supported on either side, and then his gait was very awkward, as he was unable to direct the muscular movements. He had been under the ordinary treatment of tonics, &c. for a long time, without any benefit; as a last resource, sparks were ordered to be drawn from the region of the spine. At the end of two months he was well, and has continued so up to this time. Many similar cases might be cited were it necessary.

As it is the sole object of the author to make this work a record of the progress of Electricity as applied to Medicine, he takes the liberty of soliciting from any practitioners, who may have derived advantage in its application, particulars of the cases in which it has proved efficacious; addressed to the care of the publishers, Messrs. T. and R. WILLATS, 98, Cheapside.

THE END.

ELECTRICAL, GALVANIC, & ELECTRO-MAGNETIC APPARATUS,

FOR THE APPLICATION OF
MEDICAL ELECTRICITY,

MANUFACTURED AND SOLD BY
T. & R. WILLATS,
PHILOSOPHICAL INSTRUMENT MAKERS,
AND
OPTICIANS,
98, CHEAPSIDE, LONDON.

FRictional Electricity.

			£.	s.	d.
CYLINDER ELECTRICAL MACHINES, (<i>Fig. 2</i>)					
packed in case, with Medical Apparatus, consisting of					
Medical Leyden Jar, pair of Directors, Amalgam,					
Chain, Clamp, &c.					
			5	5	0
Second Size Do.	Do.	.....	7	7	0
Large Size Do.	Do.	.....	10	10	0
Twelve-Inch Plate Electrical Machine, (<i>Fig. 1.</i>) with Elec-					
trometer attached to stand, Medical Leyden Jar, Pair					
of Directors, Clamp, Chain, Amalgam, &c. packed in					
case					
		complete	6	10	0
Fifteen-Inch Do.	Do.	..... complete	7	7	0
Eighteen-Inch Do.	Do.	..... complete	10	10	0
Medical Leyden Jars					
		5s. 7s. 6d.	0	10	0
Cuthbertson's Discharging Electrometer					
			2	2	0

Thomas & Richard Willats,

	£.	s.	d.
Lane's Discharging Electrometer, for regulating the charge of a Leyden Jar	0	7	0
Medical Jars, mounted with Lane's Discharging Electrometer, to regulate the intensity of a Shock given to a Patient (<i>Fig. 3</i>)	0	10	6
Medical Electrical Directors, for passing a Shock through any particular part of the body (<i>Figs. 4 & 5</i>) ....each	0	3	6
Insulated Stools for Medical purposes	0	15	0
Bottle Directors, for giving slight Shocks to Invalids, from	0	5	0
Jointed Dischargers, with insulated Glass Handles, 8s. 10s.	0	12	0
Apparatus for administering Frictional Electricity to the Eye (<i>Fig. 6</i>)	0	5	0
Do. do. do. to the Ear (<i>Fig. 7</i>)	0	5	0
Do. do. do. to the Teeth	0	5	0
Sparking Balls, covered with prepared Flannel from	0	2	6
Amalgam	0	1	0
Brass Chain	0	0	6

BATTERIES OF ALL SIZES.

A great variety of Apparatus adapted for illustrating the principles and properties of Electricity always on hand—Vide
WILLATS'S ILLUSTRATED CATALOGUE.

CALVANISM, OR VOLTAIC ELECTRICITY.

CRUICKSHANK'S BATTERIES, in Mahogany Troughs, for Medical purposes (*Fig. 7*)—

25 pairs of Plates ..	2 $\frac{1}{4}$ in.	1	1	0
50 do. do. ..	2 $\frac{1}{4}$ in. .	1	12	0
50 do. do. ..	3 in.	2	10	0
25 do. do. ..	4 in.	2	8	0

DR. WOLLASTON'S BATTERY of Twelve Pairs of 4-inch Plates, in Porcelain Trough (*Fig. 8*)

2 2 0

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Pints, do.	"	0	10 0
Do. in Glass Cell	"	0	13 6
Quarts, do.	"	0	17 6
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A Series of Six Half-Pint Batteries, mounted in Earthen- ware Cells, and Mahogany Tray		2	10 0
Do. Six Pint do.		3	3 0
Smee's Battery arranged in Wollaston's Troughs of 12 cells and double Zincs (<i>Fig. 10</i>)		5	5 0
Do. do. larger size		6	6 0
GROVE'S NITRIC ACID BATTERIES, in rectangular or circular Earthenware Cells, with porous diaphragms, from			
Do. do. in series of 6, in Mahogany Tray, &c. (<i>Fig. 11</i>) from		3	3 0
DANIELL'S CONSTANT BATTERIES, in a variety of forms, single cells, from			
Do. do. in a series of 6, in a Mahogany Tray, (<i>Fig. 12</i>) from	£1. 10s. to	3	3 0
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